

The experience of well and ill-being among elite dancers: A test of basic needs theory

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ABSTRACTS

SYMPOSIA

SPSS3-01

Invited symposium: The role of implicit cognitions in sport

Symposium chair: R. Masters

Institute of Human Performance, University of Hong Kong, Hong Kong

Many (or even most) fundamental cognitive operations that are driven by stimuli in our environment occur implicitly and generate knowledge that is “always ahead of the capability of its possessor to explicate” (Reber, 1993: *Implicit learning and tacit knowledge: An essay on the cognitive unconscious*. Oxford: Oxford University Press). The study of implicit processes in sport has developed primarily within the field of attention and motor learning (for a review see Masters & Maxwell, 2004. In *Skill acquisition in sport: research, theory and practice*, edited by A. M. Williams & N. J. Hodges. London: Routledge).

Helmholtz (1867: *Treatise on physiological optics*. New York: Dover) proposed that perception relies upon a process of “unconscious inference” in which knowledge is encoded automatically without awareness, but it is only recently that researchers have begun to explore more directly the relationship between perception and performance in different sport environments and to realise that our perceptions of the environment can be dramatically influenced by cognitive processes of which we are unaware (see, for example, Masters, van der Kamp, & Jackson, 2007: *Psychological Science*, 18, 222–223).

The purpose of this symposium is to present recent research that explores the influence of implicit processes on perception and performance in a variety of different sport contexts. Rich Masters (Institute of Human Performance, The University of Hong Kong) will provide a brief overview of the background to the work and will show how the different presentations are integrated within the theme of implicit cognition in sport. Rob Jackson (School of Sport & Education, Brunel University) will discuss the different ways in which expert performers and novice performers (in soccer) are influenced by

deceptive movements that are designed to cause (mis)perception. John van der Kamp (Research Institute Move, VU University) will discuss whether goalkeepers can influence the perceptions (and perhaps the actions) of penalty-takers by imitating visual illusions. Jamie Poulton (Institute of Human Performance, The University of Hong Kong) will present a series of studies that show reputation can have a dramatic effect on perceptions of the size of an opponent. Finally, Rich Masters will present a study, which suggests that psychological pressure amplifies perceptions of the size and weight of objects or implements in sport, but only in those performers who are successful rather than unsuccessful under pressure.

Presentation 1: Real or fake? Expertise and the ability to distinguish between genuine and deceptive movement

R. C. Jackson^{1,2} & J. Lee¹

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The ability to anticipate the actions of an opponent is a hallmark of expertise in sports such as badminton, tennis, soccer and squash. Logically, the ability to utilise advance visual information leaves experts vulnerable to deception (Jackson *et al.*, 2006: *Acta Psychologica*, 123, 355–371). As a consequence, we hypothesised that experts would have become more adept at distinguishing genuine from deceptive movement than their less-skilled counterparts.

A two-choice prediction task was constructed in which three highly-skilled soccer players were filmed dribbling the ball towards the camera then changing direction either with or without deceptive movement. In the deceptive trials, the model performed a “stepover” to fake moving in one direction before going in the opposite direction. The test was comprised of 96 trials (32 from each player), made

Table I. Mean proportion of correct responses (\pm standard error) for each group on “normal” and deceptive trials for each occlusion condition.

	Occlusion condition			
	T1 (−160 ms)	T2 (−80 ms)	T3 (0 ms)	T4 (+80 ms)
High skilled				
Normal	0.89 \pm 0.03	0.91 \pm 0.02	0.96 \pm 0.02	0.98 \pm 0.01
Deceptive	0.54 \pm 0.02	0.75 \pm 0.05	0.90 \pm 0.05	0.90 \pm 0.05
Low skilled				
Normal	0.87 \pm 0.03	0.97 \pm 0.02	0.96 \pm 0.02	0.99 \pm 0.01
Deceptive	0.21 \pm 0.05	0.24 \pm 0.05	0.34 \pm 0.05	0.67 \pm 0.05

up video sequences that were edited at four different points relative to the final frame before the foot contacted (or would have contacted) the ball (t1: −160 ms, t2: −80 ms, t3: 0 ms, t4: +80 ms). With institutional ethics approval, 15 high-skilled (mean age = 21.0 years, $s = 1.7$, mean experience = 12.0 years, $s = 1.7$) and 15 low-skilled (mean age = 22.0 years, $s = 1.6$, mean experience = 3.1 years, $s = 2.9$) soccer players viewed the video sequences. After each clip, they indicated their direction judgment (left or right) and rated their confidence on a 5-point Likert-type scale from 1 (not at all confident) to 5 (extremely confident). The performance data were subjected to an arcsine transformation and analysed by way of a $2 \times 2 \times 4$ (Expertise \times Deception \times Occlusion) ANOVA. The univariate analysis revealed a significant three-way interaction ($F_{3,84} = 3.41$, $P < 0.05$, $\eta_p^2 = 0.11$). This reflected that performance of high-skilled and low-skilled participants was similar on “normal” trials ($P = 0.15$, $\eta_p^2 = 0.07$) whereas high-skilled participants clearly outperformed low skilled participants on deceptive trials ($P < 0.01$, $\eta_p^2 = 0.65$). Indeed, low-skilled participants performed well below chance on deceptive trials at t1 (21%), t2 (24%) and t3 (34%). Both groups were more confident about their judgments on “normal” trials (mean 4.09, $SE = 0.11$) than deceptive trials (mean 3.27, $SE = 0.11$) (Table I).

The results suggest that it is not simply anticipation but the ability to distinguish genuine from deceptive movement that characterises expertise in this type of skill.

Presentation 2: On penalty taking: Reasons why the penalty taker should ignore the goalkeeper

J. van der Kamp^{1,2} & R. S. W. Masters²

¹Research Institute Move, VU University Amsterdam, The Netherlands and ²Institute of Human Performance, University of Hong Kong, Hong Kong

The odds of scoring a penalty kick in soccer typically favour penalty takers, and yet a remarkably large percentage ($\approx 20\%$) of penalty kicks is missed. In a recent series of studies, we aimed to uncover some of the constraints related to action and perception that exert influence on the accuracy of the penalty kick.

First, we investigated the effects of altering kick direction during the run up to the ball (van der Kamp, 2006: *Journal of Sports Sciences*, 24, 467–477). A decrease in the time available to alter kick direction resulted in a higher risk of both incorrect and inaccurate shot placements, suggesting that anticipating the goalkeeper’s movements may degrade penalty kick performance, mainly due to insufficient time to modify the kicking action. In a second study, we found that when the penalty taker’s visual attention (i.e. point of gaze) was drawn to the goalkeeper, this resulted in less accurate ball placement (Bakker *et al.*, 2006: *International Journal of Sport Psychology*, 37, 265–280). Again, this suggests that anticipation of the goalkeeper’s movements may degrade penalty kick performance, because it leaves insufficient time to redirect visual attention to the proper target location necessary for accurate aiming. Finally, we showed that a goalkeeper can influence a penalty-taker’s actions by assuming postures that mimic illusionary Müller-Lyer configurations (van der Kamp & Masters, in press: *Perception*). We found that a goalkeeper’s posture affects the perception of his or her height and that this influences penalty-taking accuracy (i.e. a posture which resembles a wing-out Müller-Lyer configuration results in the ball being placed lower and further from the goalkeeper).

We conclude that for a successful conversion the penalty kicker would be wise to ignore the goalkeeper’s actions. Instead, our research suggests that the penalty taker should focus attention on the location or space to which he or she intends to direct the kick.

Presentation 3: Highly rated goalkeepers are perceived as larger than life

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Our performance on a task can influence our perceptions of key components within the task environment. In a dart throwing scenario, for example, players who perform better perceive the target to be larger than those who perform worse (Wesp, Cichello, Garcia, & Davis, 2004: *Perception & Psychophysics*, 66, 1261–1267). A series of studies was designed to examine whether a soccer goalkeeper's reputation can also influence size perceptions.

Outfield members of a university football squad ($N=30$) were asked to rank their four goalkeeping counterparts by penalty saving ability. They then selected one figure from an assortment of twelve presented on an A4 sheet that best represented each goalkeeper's size relative to the goal (relative size range -25% to $+30\%$). The outfield players significantly overestimated ($+14.17\%$) the size of the #1 ranked goalkeeper ($t_{29}=7.96$, $P<0.001$) and underestimated (-9.33%) the size of the #4 ranked goalkeeper ($t_{29}=-7.02$, $P<0.001$). A follow-up study replicated this phenomenon in a second squad of competitive players ($N=32$). Of the three goalkeepers ranked, the size of the goalkeeper ranked #1 was overestimated ($+13.75\%$: $t_{31}=6.16$, $P<0.001$) and the size of the goalkeeper ranked #3 was underestimated (-8.59% : $t_{31}=-4.74$, $P<0.001$).

In a third study, we manipulated the perceived reputation of a goalkeeper. Outfield players viewed video footage of a goalkeeper making a series of four saves or the same goalkeeper being scored against four times. Relative size judgements of the goalkeeper were made prior to and following the video by observing a video still. Preliminary data of 14 players showed a Group \times Block interaction approaching significance, substantiated by a large effect size ($F_{1,12}=3.25$, $P=0.09$, $\eta_p^2=0.21$). Players who observed the goalkeeper failing to save the penalty estimated the goalkeeper to be significantly smaller following the video ($F_{1,6}=6.70$, $P<0.05$, $\eta_p^2=0.53$). Players who observed the goalkeeper making saves did not show significant changes in size perception ($P=0.36$).

Taken together, the three studies suggest that goalkeeper reputation influences perception of goalkeeper size. A logical next step is to investigate whether mistaken perceptions influence our actions.

Presentation 4: Successful performers see the world differently

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Recent performance appears to influence the way a person perceives the environment. People who are fatigued perceive hills to be steeper (e.g. Bhalla & Proffitt, 1999: *Journal of Experimental Psychology: Human Perception and Performance*, 25, 1076–1096) and in sport people who have batted successfully estimate the baseball to be bigger (Witt & Proffitt, 2005: *Psychological Science*, 16, 936–937). We asked whether psychological pressure amplifies the transient relationship between performance and perception.

Experienced basketball players ($N=35$) made 15 free-throws while seated to a standard basketball hoop (45 cm diam), using a size 7 basketball (24.5 cm diameter). Following the throws, participants were asked to estimate the weight of the ball (by lifting a container that gradually filled with sand) and the size of the hoop (by adjusting a lariat to the size of the hoop). Estimates were made with both the hoop and the ball in view and order of estimate was counterbalanced. After a rest interval (5 min) participants were informed that they were to make two final free-throws that would dictate the payment that they would receive. They made the throws, and then re-estimated the size of the hoop and the weight of the ball. Anxiety levels were assessed before and after the pressure manipulation (i.e. self-report and heart rate).

Correlation analysis revealed no significant association between mean performance prior to the pressure manipulation and estimates of size or weight (P 's > 0.05). On the basis of their performance under pressure, we divided participants into a successful ($n=16$) and an unsuccessful group ($n=19$). Two-way analysis of variance revealed an interaction ($F_{1,33}=6.78$, $P=0.01$, $\eta^2=0.17$), which when deconstructed indicated that participants who performed successfully under pressure estimated the hoop to be larger and the ball to be lighter than they had prior to the pressure manipulation ($P<0.05$). Participants who performed unsuccessfully under the pressure manipulation showed no change in estimates from pre- to post-pressure ($P>0.05\%$). For estimates of the weight of the ball, a two-way analysis of variance again revealed an interaction ($F_{1,33}=9.69$, $P=0.004$, $\eta^2=0.23$), with successful participants estimating the ball as significantly lighter after the pressure manipulation

($P < 0.05$), but unsuccessful participants showing no change ($P > 0.05$).

Perception of hoop size and ball weight was not associated with recent performance prior to the pressure intervention. This finding does not replicate Witt and Proffitt (2005: *Psychological Science*, 16, 936–937). However, our findings suggest that pressure amplified the influence of recent performance on perceptions of the environment, but only for successful performers under pressure, who perceived the hoop as larger and the ball as lighter.

SBIS4-01

Biomechanical modelling in rowing

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Mechanical modelling in rowing was originated from Alexander's 1925 paper followed by important works of McMahon, Pope, Zatsiorsky and others. The results of mechanical modelling can have valuable applications and improve rowing technique and equipment design. However, quite often pure mechanical models do not take into account the human factor, which has the biggest "share" in sporting performance.

It was found that an application of the peak force at the end of the drive would improve performance. However, this style would require much higher peak power, which must be produced by weaker muscles of the arms and trunk. Smaller muscles have lower efficiency and may not cope with the load. There were other variables, which are not included in the model: temporal structure of the drive and utilisation of elastic energy.

The mechanical modelling can be used providing: (1) models can be useless if they are too simplistic and do not take into account all significant variables; (2) a number of variables and factors are very difficult to quantify, which significantly reduces accuracy of the model; (3) the human factor must be involved in a model, which is not an easy thing to do and requires an individualised approach.

SOTS5-02

Delivering nutritional programmes to young elite rugby players

J. Griffin

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The England Rugby Academy system was set up in 2002 to enhance and encourage the development of English qualified players and for the first time to provide an integrated performance pathway for potential elite players from the grassroots of the game, into the Guinness Premiership clubs and on to the England side. The RFU has 14 Regional Academies serving specific geographical areas. Twelve sited at Premiership clubs, one at Leeds Tykes and a stand-alone Academy in the South West.

This presentation provides an insight into nutritional programmes delivered at two Guinness Premiership clubs Academies, covering an age range of 13–21 years old. It concludes with a discussion about areas of conflict.

Adolescents have dietary requirements that are different from adults, but those involved in rugby at a competitive level will also be different from their non-athletic friends because of the physiological demands of rugby that must be met by their diet. It must support their training and matches as well as their growth and development. Lifestyle issues can compromise a player's ability to meet these requirements, particularly if their time management skills are poorly developed.

Nutrition programmes, including a strong educational element, run throughout the year. A variety of different teaching methods are used to maintain player interest. Players are seen for individual consultations on a rotational basis or on-demand if there is an immediate issue that needs attention. Practical sessions play an important part in helping players to turn theory into practice.

Although the England Rugby Academy system operates well overall, there are some areas of conflict which need resolving.

Members of the support team need to work together and respect the knowledge and expertise of others. Policies on supplement usage (including choice of brand) should be decided by performance and commercial departments together. Players should be given consistent advice at club and England level.

SPSS7-01

Performance, adversity, well-being and trauma: Psychosocial explorations of the stories of high performance and professional sportspeople

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³*University of Ottawa, Canada*

This symposium focusses on exploring a variety of complex issues surrounding performance, adversity, well-being and trauma in the lives of high performance and professional sports people. The three featured papers utilise a blend of psychological and sociological analysis to shed light on some of the delicate, yet critical, interactions between these four themes in the real-world environment of elite sport.

Two prominent sport psychologists have recently suggested that, “If high-level sport were delivered in a developmentally appropriate manner, both performance and personal excellence would be possible at the same time. Yet, in practice it is quite common that personal excellence is compromised or sacrificed in the pursuit of performance excellence” (Miller & Kerr, 2002: *Journal of Applied Sport Psychology*, 14, 140–153, p. 141). In these comments, Miller and Kerr hint at (i) a widespread acceptance in elite sport that some degree of adversity, trauma and/or compromised well-being/development is part and parcel of achieving peak performance; and (ii) the idea that better developmentally-orientated support and provision for elite sportspeople might render these compromises unnecessary.

Through a variety of narrative analytical approaches, the papers in this symposium will explore these possibilities by focusing on the stories of nine high achieving mountaineers and golfers. Through adopting this kind of narrative focus, it is possible to gain appreciation of individual psychological processes within the broader socio-cultural context of participants’ lives. The themes, lessons, emotions and theoretical insights resulting from these analyses will provide an opportunity for delegates to engage in a grounded discussion of how sports scientists—alongside psychologists, coaches, performance directors, counsellors, lifestyle managers and governing body officials—may begin to respond to the challenges presented by the demands of high performance sport in the twenty-first century.

Paper 1

“We haven’t got a seat on the bus for you” or “all the seats are mine”: The consequences of narratives on the lives of two elite professional golfers

Research suggests retirement from elite sport can have profound effects on an athlete’s identity, sense of self and psychological health. This study explores how the stories an athlete tells of her life in sport come to affect her subsequent life experiences. We base our enquiry on a social constructionist conception of narrative theory which holds that storytelling is integral to the creation and maintenance of identity and sense of self. Life stories were gathered through

interviews with two professional women golfers (Christiana and Kandy) over a six year period. Through a narrative analysis of structure and form we explored each participant’s stories of living in and retiring from professional golf. We suggest that Christiana told monological performance-oriented stories which, while aligning with and being endorsed by the culture of elite sport, resulted in an exclusive athletic identity and foreclosure of alternative selves and roles. On retirement, Christiana experienced narrative wreckage, a loss of identity, mental health difficulties and considerable psychological trauma. In contrast, Kandy told dialogical discovery-oriented stories which, while being questioned and in tension with the dominant narrative that circulates within elite sport culture, created and sustained a multidimensional identity and self. Her stories and identity remained intact, authentic and continuous when she retired from tournament golf and she experienced few psychological problems.

2. That night: Exploring taboo issues in high performance sport

Over the past decade there has been greater awareness of the need to understand more about the life issues and the life course of elite athlete if we are to unravel the complexities in high performance sport and make better provision for these individuals across their sport careers.

In terms of exploring *life issues* a number of scholars have suggested that “some territories of experience are dangerous to explore” (Marshall, 1995: *International Review of Women and Leadership*, 1, 1–10, p. 3) which means they remain under-researched. As a consequence, the ethical and moral questions these issues pose are not acknowledged, understood or debated. In terms of sport psychology practice, the attitude and beliefs of a particular sport psychologists can also contribute to an athlete remaining silent about dangerous or taboo subjects even when they may be traumatic or cause emotional distress (Van Raalte & Anderson, 2007: *The Sport Psychologist*, 227–242).

A further impediment to exploring, debating and understanding taboo subjects among elite athletes is the reliance of positivistic nomothetic designs. While these are well suited to sample large populations or understand the frequency of a particular problem they are less well suited to explore issues which can be hidden by the athlete and/or are silenced within the sport culture.

In this paper we present findings from our ongoing longitudinal life history research with athletes in high performance sport. We identify one type of silenced story from our research and contextualise the issue

by provide a complex life-history account of how and why an athlete might compromise their own well being in the hope of hiding one stigmatised identity over another equally stigmatised identity. We provide an example which also shows why an athlete might remain silent about such issues during consultancy in the hope that the presentation of this data will provide an educational opportunity for delegates to debate how we might provide better support to athletes experiencing similar emotional distress and psychological trauma.

3. Tales from the field: A cognitive dissonance perspective on coping with adversity on Mt. Everest

Scaling mountains in high altitude environments, where oxygen is sparse and survival is tenuous, is an activity that presents a host of profound and difficult challenges that a climber has to deal with. This ethnographic study examined how a group of high altitude climbers ($N = 6$) coped with adversity during an attempt to scale Mt. Everest using Festinger's (1957) cognitive dissonance theory as the framework. Data were collected via participant observation, interviews and a field diary. Each data source was subjected to a content mode of analysis. Two key themes emerged in relation to the ways that the climbers coped with adversity on the mountain showing cognitive work aimed at (a) changing their beliefs and (b) changing their values. The findings highlight how the climbers drew upon cognitive dissonance reduction strategies in their tales of coping with adversity on the mountain.

HOTS4-01

Are we asking the wrong questions to be thin about disordered eating?

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Traditionally, we view eating disorders such as anorexia and bulimia, very differently from obesity. This has resulted in research and interventions being developed along alternative lines. What if they are, in fact, at opposite ends of a continuum and we are approaching the current obesity epidemic by asking the wrong questions? This symposium explores this as a concept and the context of eating disorders as being along a continuum, as well as how current

practices at one end of the continuum can impact and influence the other.

Prof. Julia Buckroyd will draw on recent research and her work with dancers and obese individuals to draw comparisons and similarities between these two groups. Janet Gray and Claire Mooney will utilise their experiences as a CBT counsellor and dietician in an NHS weight loss clinic and Dr. Hilary Matheson will approach it from an eating behaviour perspective and how exercisers shift their perspective and patterns of eating.

Changing the shape of eating disorders

In recent years research has demonstrated that the conventional divisions of eating disorders into discrete conditions do not bear detailed examination. Diagnostic criteria for DSM have changed (see for example Waller, 2008: Chapter 4. In *Psychological responses to eating disorders and obesity*, 75–84); a majority of patients in some studies have presented with eating pathology, which does not fit into established criteria (e.g. Fairburn & Harrison, 2003: *Lancet*, 361, 407–416); a significant number of sufferers have been shown to shift diagnosis from one eating disorder to another (Fairburn & Harrison, 2003: *Lancet*, 361, 407–416). A picture is emerging of a group of people whose common denominator is the misuse of food but whose behaviour in relation to food may well change over time and is not readily categorised into discrete conditions.

Other research is beginning to show that a substantial minority of obese people use food in a way that suggests an eating disorder. Thirty percent of obese people seeking treatment are diagnosable with Binge Eating Disorder; as many as 46% of obese people are known to binge (Gluck et al., 2004: *Annals of the New York Academy of Sciences*, 1032, 202–207) and binge eating and emotional eating are known to be associated.

In the past 15 years a substantial volume of research has demonstrated underlying commonalities in the developmental and emotional history of those with disordered eating across the spectrum of disordered eating from restricting anorexics to bingeing obese people. There is evidence that insecure or avoidant attachment patterns are to be expected in this group of people and that a history of trauma is common (Buckroyd & Rother, 2007: Introduction. In *Therapeutic Groups for Obese Women*, xv–xxiv). Current neuroscientific evidence suggests that poor attachment history and/or trauma leads to poor affect regulation and the consequent adoption of compulsive behaviours of all kinds to manage emotional events (e.g. Schore, 2001: *Infant Mental Health Journal*, 22 (1–22), 7–66). It looks increasingly likely that food misuse across all forms of

disordered eating is demonstrably a coping mechanism with identifiable neurochemical consequences (Will et al., 2003: *Journal of Neuroscience*, 23, 2882–2888) which are used for self-medication.

The implications of this substantial body of research for treatment, including particularly the treatment of a substantial number of obese people, are considerable. If food (or its restriction) is being used for affect regulation then it is an essential part of the person's emotional management system. It will not be surrendered unless some alternative system can be put in its place. The task of treatment is then one of addressing emotional and developmental deficits so that the client can adopt the more ordinary strategies of affect management, especially those relating to self talk and relationship with others, in the process of relinquishing the use of food.

The presentation will discuss attempts to translate this research base into ways of working with eating disordered people across the continuum.

Using cognitive behavioural therapy as a tool for changing behaviours

The cognitive model for working with eating disorders (Fairburn & Wilson, 1993: *Binge eating: nature, assessment and treatment*. New York: The Guilford Press) places the over evaluation attached to idealised body weight and shape, together with low self-esteem, as central to the problem. This is most apparent in Bulimia Nervosa (BN) where the individual will often use a variety of methods to achieve their ideal weight and shape. Methods can include purging in one form or another; either through the misuse of laxatives or diuretics, excessive exercise or strict dieting. When a diet is strict, involving specific goals, repeated "failures" are inevitable. This becomes demoralizing and can lead to temporary abandonment of the diet and possibly a binge, having the effect of perpetuating the need to create an even stricter dietary regime. However, if the individual is unable to regulate their shape or weight at all, there is an inevitable weight gain. The prevalence of this pattern of binge eating in obese individuals is not widely known, however there is some evidence to suggest that over 20% of overweight individuals applying for help in losing weight share similar problems to individuals with Binge Eating (Fairburn & Wilson, 1993: *Binge eating: nature, assessment and treatment*. New York: The Guilford Press).

As a result of this Government-funded project, a multi disciplinary team consisting of a dietician, a consultant physician with a special interest in obesity, two specialist nurses, and a cognitive behavioural

psychotherapist were employed to tackle obesity in the Welsh Valleys.

The role of the CB Therapist was to support and work with individuals who might need psychological intervention in order to help with weight loss.

Treatment for Binge Eating in obesity using Cognitive Behavioural Therapy (CBT) began by educating the individual about the cognitive view on the maintenance of the problem and the need for both cognitive and behavioural change. It moved on to encourage the individual to monitor not only the food they ate, but the context in which food was eaten. Concerns about weight and shape in relation to self esteem were addressed and the individual was encouraged to use techniques to modify problematic thoughts and attitudes to food and body image.

There was some evidence to indicate that this adapted model for working with BN appeared to benefit some, and as such, might suggest that some individuals with obesity share similar cognitive and behavioural patterns to those with a recognised eating disorder such as Bulimia Nervosa.

Changing the shape of traditional approaches to obese individuals

The traditional dietary approach to treating obesity was to question the client directly about what their current eating patterns were and then to offer "advice" on what the client needed to change in order to achieve weight loss. In recent years evidence has shown that interventions that take account of the behavioural context in which eating takes place are more likely to be successful (NICE, 2006). It is worth, therefore, considering where the dietetic approach to weight management can fit in within a wider model of treatment including cognitive behaviour therapy, for example.

Dieticians working with obesity have recognised the need to explore not just the client's eating patterns but the context and possible contributing factors for a client's eating behaviours. This can be done through a detailed assessment process.

Assessment is considered to be the foundation of good management, enabling the dietician to gain insight into the client's thoughts on their weight and how they envisage the dietician helping them. It is also an opportunity for the client to evaluate the practitioner and to form a collaborative approach, which should underpin the client/practitioner relationship. Through good assessment the dietician can go on to gain an insight into clients' expectations of treatment and their motivations for wanting to achieve weight loss, which can help to frame agreed goals of treatment.

In addition, the dietician should explore the client's weight history and dieting history. This serves as an opportunity for the dietician to convey empathy and acknowledge each client's frustrations regarding weight loss. This can also help to identify recurrent themes and factors which may be helpful or unhelpful to future weight loss attempts. The core communication skills of the dietician are important and strategies for eliciting dietary information while minimising associated guilt or embarrassment, such as reflection, paraphrasing, open questioning and summarisation should be used.

The most important element to the assessment and treatment of obesity is that a collaborative approach is taken between the client and the dietician. Alongside this, building a picture of current lifestyle habits and the positive and negative influences upon these behaviours provides the basis on which a plan of action can be agreed.

The presentation will explore the concept of building this picture and how it can be utilised to assist in changing eating behaviours and lifestyle habits, when combined with additional support, such as CBT.

Patterns of exercise and eating behaviours

Attitudes and beliefs are related to behavioural goals, as are the perceived importance of diet and links to disease. The willingness to adopt changes in dietary practices can, therefore, be said to be linked to these attitudes and beliefs (Howarth, 1999: *Nutrition Research Reviews*, 12, 281–317).

Lien et al. (2002: *Public Health Nutrition*, 5(5), 671–681) indicate there is a need for studies to be investigating potential mechanisms which provide the mediating connections between changes in personal and environmental factors and changes in eating behaviours. Studies have also shown that the combination of changes in eating and physical activity behaviours can improve long-term weight loss compared with either behaviour alone (Jakicic, Wing, & Winters-Hart, 2002: *Medicine & Science in Sports & Exercise*, 34, 1653–1659). However, when it comes to competitive sport healthy eating is not always the norm. Elliot et al. (2004: *Archives of Pediatrics & Adolescent Medicine*, 158, 1043–1049) have shown that sport teams can be effective natural vehicles for gender-specific, peer-led curricula to promote healthy lifestyles and to deter disordered eating. The objective of this presentation is to draw out the links between these factors and determine where, along a proposed continuum of eating behaviours, athletes may lie and what this can tell us about our approach to disordered eating.

YPSS3-01

“No athlete is an island”: The role of interpersonal factors in sport

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Athletes are involved in numerous interpersonal relationships, each of which have the potential to influence their sporting life. These relationships can be of a sporting nature (e.g. with their coach or other athletes) or more personal (e.g. with a romantic partner, family members or friends). The proposed symposium would aim to present a series of three talks that would serve to highlight the importance of the role played by interpersonal relationships in the sporting context. This contemporary and exciting body of research employs a range of theoretical and methodological approaches to investigate this growing research domain. This symposium therefore falls under the “Performing Athletes” theme of this year’s conference.

The first presentation would report a study which explored the links between the different qualities of an athlete’s romantic relationship and their sports performance in a Greek sample.

The second talk would focus on a study involving young people within physical education classes. They consider the associations between achievement goals, motivation and friendship quality.

The third and final presentation would discuss the conceptualisation and measurement of the use of relationship maintenance strategies within the coach-athlete relationship. The COMPASS model of relationship maintenance in sport is proposed along with an associated instrument which is designed to measure the use of maintenance strategies.

The symposium would bring together some of the leading researchers working in this developing field and would contain three talks which would no doubt spark some interesting debate. Each of the presentations is now outlined in more detail.

Associations between the quality of athletes’ romantic relationships and performance in a Greek sample

Research in psychology concerning special populations such as sport performers and personal relationship issues has been almost non-existent (Wood & Duck, 1995). Our research programme aimed to

fill this gap by examining the quality of personal relationships established between professional athletes and their partners in Greece and the United Kingdom. The premise of this research is that athletes, particularly those who operate at high performance levels, are required to commit wholeheartedly to their sport and spend long hours of training. Moreover, athletes face demanding work conditions as well as highly competitive and uncertain careers that can potentially cause intense relationship dynamics and difficulties with their partners. This presentation will present findings from data collected in Greece. Greek male and female athletes who competed at a good standard participated in the study. A multi-section relationship-oriented questionnaire measuring such constructs as closeness, commitment, and empathy as well as performance satisfaction was administered to athletes who were involved in a romantic or marital relationship. Data were analysed using structural equation modelling to test the prediction of sporting performance in terms of the relationship variables measured.

Achievement goals, motivation and friendship quality in physical education classes

The purpose of the present study was to examine the interpersonal and achievement-oriented correlates of pursuing approach and avoidance achievement goals in school physical education (PE). One hundred and fifty-eight students ($n=102$ girls, $n=56$ boys; M age = 13.30 years, $SD=0.98$) from one school in the East Midlands, England, completed measures of mastery and performance-approach and avoidance goals, perceived competence in PE, perceived friendship quality in the PE class, and self reports of behavioural and emotional investment in PE. In addition, teachers provided ratings of each student's typical behavioural engagement in their PE lessons. Hierarchical multiple regression analyses revealed that, after controlling for gender and perceived competence, mastery-approach goals significantly predicted perceived self-esteem enhancement and supportiveness of a best friend in the PE class ($\beta=0.348$, $P<0.001$). No other friendship dimensions were associated with achievement goal adoption. Mastery-approach goals also predicted both self-reported ($\beta=0.416$, $P<0.001$) and teacher-rated ($\beta=0.384$, $P<0.001$) engagement in PE. Null relations of self-reported and teacher-rated engagement with mastery-avoidance, performance-approach and performance-avoidance goals were evident. These results point towards the adaptive consequences for students of pursuing mastery-approach goals in terms of working hard, paying attention, not being discouraged after failure,

and feeling positive about their PE experience. Moreover mastery-approach goals appear to help foster friendships in class that are characterised by mutual supportiveness and enhancement of self-esteem.

Conceptualising and measuring relationship maintenance strategies in the coach-athlete relationship

Although the investigation of relationship maintenance strategies has received significant attention in romantic/familial relationships, it remains a relatively unexplored topic with respect to the coach-athlete relationship. The present study aimed to develop and validate a measure of the extent to which these maintenance strategies were used within a coach-athlete relationship and whether their use could predict the quality of the relationship in terms of closeness, commitment and complementarity. A set of 50 items were developed and evidence of their face validity was established using an expert panel. These items were then given to a sample ($N=251$) comprised of 106 coaches and 145 athletes from a range of individual and team sports and competitive levels. Principle Components Analysis was employed to explore the underlying factor structure and to aid item deletion. A seven factor structure was derived which contained 28 items. The seven sub-scales were labelled Conflict management, openness, motivational, Prevention, Assurance, Support and Social networks. The resultant sub-scales were able to explain a relatively high amount of the variance in perceptions of closeness, commitment and complementarity which provided some evidence of the criterion validity of the newly developed measure, which was entitled the Coach-athlete Relationship Maintenance Questionnaire (CARM-Q). Future research directions are considered along with suggestions as to how the present research may contribute to interventions and coach education programmes.

Conclusion

The symposium would therefore highlight the role of the relationships between athletes and their romantic partners, friends and coaches using a range of methodological approaches. It serves to emphasise the importance of considering the influence of interpersonal factors in sport. Furthermore, this research further develops the body of information which can inform coaches, athletes, sport psychologists and coach education programmes in the drive towards the "professionalisation" of coaching and the optimisation of coaches and athletes' psychological well-being, satisfaction, development and performance.

YOTS5-01**Sport and exercise psychology: A sport and exercise science alliance?**

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This presentation will examine the extent to which sport and exercise psychology is accessible within, and accountable to, the discipline of psychology as a whole. A historical and cumulative approach will be taken in order to highlight developments in the field of sport and exercise psychology. Data from a content analysis of journals published across several fields of applied psychology (sport and exercise psychology, community psychology, counselling

psychology, health psychology and applied developmental psychology) will also be presented. Results suggest that sport and exercise psychology is relatively similar to other sub-disciplines of psychology in terms of the proportion of references made to published work within the sub-discipline, itself. In comparison to other fields of applied psychology, sport and exercise psychology is cited to a lesser extent within its own sub-disciplines and this trend has changed over time. The proportion of references made to sport and exercise psychology was found to be considerably more when compared to other areas of applied psychology. These results will be discussed by examining how sport and exercise psychology defines itself as a field, as well as by taking into account the relationship between sport and exercise psychology and sport and exercise science.

ORAL COMMUNICATIONS

SBIO1-01

The relationship between lower limb stiffness and ground reaction forces in well-trained middle distance runners

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Studies into animal locomotion have shown that aerobic demand can be minimised by tendons storing and recovering gravity's "free" energy during ground contact. This can be characterised by high leg-spring stiffness (k_{leg}). Similar studies have reported a relationship between the energetic cost of locomotion and the application of ground force (loading rate; LR) during ground contact. Faster application of ground forces requires greater muscular activation, increasing the energetic demand. It is presently unclear which of these two factors (k_{leg} or LR) has a greater influence on the economy of human running. The present study will determine whether k_{leg} or LR is the most significant in determining aerobic demand in well-trained runners and how they could be used to predict running economy (RE).

Ground reaction forces (GRFs) of twelve well-trained middle distance runners ($\dot{V}\text{O}_{2\text{max}} = 68.6 \text{ mlO}_2 \cdot \text{kg} \cdot \text{min}^{-1} \pm 6.9$) were recorded using two force platforms positioned flush with the running surface of an indoor athletics track. Running velocities ranged from 14 to 20 $\text{Km} \cdot \text{h}^{-1}$. Contact time (T_c), maximum vertical force (F_{max}), LR, total vertical impulse ($\int v$), vertical displacement (d_v), vertical stiffness (k_{vert}) and leg stiffness (k_{leg}) were calculated from the GRFs. RE was measured using a standardised treadmill protocol.

There was no significant correlation between RE and k_{leg} . LR, d_v and T_c (Pearson correlation 0.44, 0.29 and 0.28, respectively) were significantly correlated with RE. Stepwise multiple regression shows that LR (Beta value = 0.63) and k_{vert} (Beta value 0.32) were most significant variables predicting RE; k_{leg} was not a significant predictor of RE.

The results show that a fast loading rate, possibly caused by large vertical oscillation of the runner's

centre of mass and high GRFs, results in poor RE; greater muscular activation would be required to absorb the higher landing forces. Leg stiffness, possibly indicative of elastic recoil, does not correlate well with RE. This suggests that runners who display very stiff characteristics are not necessarily the most economical in terms of aerobic demand. Tendon elasticity may remain a significant factor, with the runners here utilising individual leg-spring mechanics to optimise tendon energy absorption.

It is possible that these runners adopt a kinetic pattern that is optimum for their own muscle-tendon properties while controlling for eccentric loading. Further study is required to investigate the relationship between muscle-tendon unit properties and running mechanics of stiff and compliant runners.

SBIO1-02

Gait variable in triathletes and runners

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Novacheck (1998: *Gait and Posture*, 7, 77–95) proposed that, as running speed increases, pelvic tilt increases to maximise horizontal propulsive forces. These forces form a third of the metabolic cost of running (Chang & Kram, 1999: *Journal of Applied Physiology*, 86(5), 1657–1662). At a given speed, greater pelvic tilt could therefore help reduce metabolic cost. Hip range of motion (ROM) may influence stride length. Furthermore, maximum pelvic tilt angle and hip extension correlate (Schache *et al.*, 2000: *British Journal of Sports Medicine*, 34, 279–283) so both may affect stride length. Pelvic tilt angle relative to standing posture, however, would provide information on the origin of any difference in absolute pelvic tilt. Triathletes cycle with the hip relatively flexed and little pelvic movement. This may limit functional hip ROM and pelvic tilt during running potentially shortening the stride. No previous studies have compared stride length, pelvic tilt and hip ROM of triathletes with runners. This study aims to compare these variables across a range of speeds.

Following ethical approval, 11 faster runners (FR) 10 slower runners (SLR) and 11 triathletes (TR)

with mean 10 km times of 32, 40 and 40 min ran on a treadmill for 8×1 min at randomised speeds (12–19 km/h). 3D-kinematic data were recorded.

Significant main effects for group occurred for stride length [$F(2,29) = 4.089$, $P = 0.027$], absolute pelvic tilt [$F(2,29) = 7.127$, $P < 0.01$], relative maximum pelvic tilt [$F(2,29) = 4.576$, $P = 0.02$], maximum thigh extension [$F(2,29) = 8.507$, $P < 0.01$] and hip ROM [$F(2,29) = 5.418$, $P = 0.01$]. Post-hoc tests revealed hip ROM, maximum thigh extension and stride length significantly differ between TR and FR. FR exhibit the longest stride length and greatest hip ROM and thigh extension. TR displayed the shortest stride length and least hip ROM and thigh extension. Both FR and SLR show significantly greater absolute pelvic tilt than TR but FR and SLR were not different. SLR had significantly greater relative pelvic tilt than TR.

The results show that triathletes have a shorter stride and reduced pelvic tilt, hip ROM and thigh extension compared with runners. Increased pelvic tilt allows greater thigh extension and hip ROM during the gait cycle and consequently a longer stride. Potentially this could maximise horizontal propulsive forces for a given metabolic cost. Reduced hip ROM and pelvic tilt observed in the TR group could be due to cycling training when the hip is maintained in a flexed position and moves over a shorter ROM than in running.

SBIO1-04

The force-length relationship *in vivo*: A simulation study

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The force-length relationship of muscle is a fundamental mechanical property of muscle and an important determinant of resultant joint moments. *In vivo* a muscle may operate over all or only part (ascending limb, descending limb or plateau region) of the force-length curve for physiologically realistic ranges of motion. There are several possible sources of this variability, for example anatomical and architectural differences and differences in muscle-tendon mechanical properties. Such features are reflected in the parameters usually included in muscle models. Reported values for these parameters typically vary between different muscles and vary between participants for a given muscle. The purpose of this study was to determine the effect of these parameters on the section of the force-length relationship that a muscle operates over. A general-

ised model of a mono-articular muscle-tendon complex operating over a 90 degree joint range of motion was formulated and variables were systematically varied. The parameters investigated were: ratio of tendon resting length to muscle fibre optimum length (L_{TR}/L_{FOPT}) (varied from 0.5 to 11.5), ratio of muscle fibre optimum length to average moment arm (L_{FOPT}/r) (0.5–5), normalised tendon strain at maximum isometric force (c) (0–8%), muscle fibre pennation angle (θ_{PENN}) (0–45 degrees). The joint angle at which the optimum muscle fibre length occurred (θ_{REF}) was varied throughout the 90 degree range of motion. The values for each parameter were based on reported ranges for five mono-articular muscles with different functional roles. It was shown that L_{TR}/L_{FOPT} was important in determining the section of the force-length relationship that a muscle operated over. The effect of this ratio was modulated by L_{FOPT}/r . The muscle operated over only one limb at intermediate values of these two ratios ($L_{TR}/L_{FOPT} = 5$; $L_{FOPT}/r = 3$), whether this was the ascending or descending limb was determined by the precise relative values of c , θ_{PENN} , θ_{REF} , and L_{TR}/L_{FOPT} . At higher values of the two ratios the whole force-length relationship was used, at lower values only a small section of one limb was used. It was concluded that that inter-individual variability in the expressed section of the force-length relationship is possible, particularly for muscles with intermediate values of L_{FOPT}/r and L_{TR}/L_{FOPT} such as the brachialis and vastus lateralis. These results have implications for understanding the training adaptations of muscles for sport.

SBIO1-05

Does superficial taping of rigid body marker clusters improve representation of bone movements during impact landings?

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Soft tissue artefact and its effects on measures of bone movement are well-documented (Reinschmidt *et al.*, 1997: *Gait and Posture*, 6, 98–109). Marker clusters are one method of minimising soft tissue artefact, with rigid-body bases considered an optimal design (Manal *et al.*, 2000: *Gait and Posture*, 11, 38–45). The aim of this pilot study was to investigate whether superficial taping of rigid-body marker clusters could improve the representation of the movement of underlying bone during high impact landings.

Table I. Magnitude of angular differences between bone and cluster; and time of maximum error.

Condition	Range of bone/cluster angular difference [degrees]	RMS angular difference [degrees]	Time of maximum angular error post-impact [ms]
Untaped	-1 to 17	6.7	34
Taped	1 to 15	7.5	40

Following institutional ethical approval, sagittal plane high-speed video (1000 Hz) was obtained from one female subject (age 20 years; mass 61.4 kg; height 1.71 m) performing a static standing trial and a series of maximal heel-strike stamps. Two CODA batteries and four active markers, placed upon a rigid base (total mass: 54.6 g) were attached to the lateral mid-shank using double-sided tape, and for half the trials were secured with extra tape around the cluster and shank. A 6-point model was manually digitised from 50 ms before impact to when skin movement was judged to have stopped, and reconstructed using affine scaling. A line joining the lateral tibial condyle and lateral malleolus was considered representative of the underlying bone axis. The angle given by the cluster markers was compared to that from the bone axis.

Results (presented in Table I) show that additional taping over the cluster delayed the instant of maximum angular error post impact, but did not reduce the RMS difference in angle measured from bone and the cluster.

Results support previous findings that soft tissue artefact introduces error into kinematic calculations. However, taping appeared to negatively affect accuracy compared to untaped conditions. Future work needs to identify more suitable cluster attachment techniques, and the use of frequency analysis could facilitate optimal smoothing protocols.

SBIO1-06

Assessment of modern glove design on forearm myoelectric fatigue during simulated windsurfing

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Previous research in windsurfing has shown that increasing boom diameter can have a negative effect on muscular performance (Campillo, Leszczynski, Marthe, & Hespel, 2007: *Journal of Sports Science and Medicine*, 6, 135–141). Colder climates require

equipment to protect extremities when windsurfing. Gloves are worn for thermal comfort but these may effect performance by increasing grip diameter and therefore reducing electromyographic (EMG) time to fatigue. The purpose of this study was to examine myoelectric fatigue during simulated windsurfing whilst wearing two types of windsurfing glove.

Ten windsurfers (> 4 years experience) performed an isometric activity specific stance on a windsurf simulator, with a pronated grip on a standard diameter boom. Each subject was tested whilst wearing full finger gloves, palmless mitts and no gloves. Bipolar, active surface electrodes were attached bilaterally to the Brachioradialis, Flexi Carpi Ulnaris and the rear leg Tibialis Anterior. Real time EMG data were collected through an 8-channel Datalog EMG system (Biometrics, UK). Each condition lasted until fatigue or a duration of 5 min. EMG median frequency was calculated from the power density spectrum, Wilcoxon Signed Ranks tests identified significant shifts in mean EMG median frequency for all muscles between the first, middle and last 20 s. The full finger glove condition displayed a significantly shorter time to fatigue than both other conditions. Fatigue occurred in all forearm muscles ($P \leq 0.05$) but there was no significant difference in rate of fatigue between conditions ($P \leq 0.05$). The Tibialis Anterior showed no significant shift in the median frequency throughout the activity ($P > 0.05$).

It was concluded that myoelectric fatigue occurred in the forearm muscles, however, the rate of fatigue was not effected by the glove conditions. The Tibialis Anterior showed no myoelectric fatigue, this could be due to either the specificity of the laboratory simulator or may indicate that this muscle does not have an active role in windsurfing. The full finger gloves significantly reduced grip performance in terms of time to fatigue, while palmless mitts did not affect performance compared to wearing no gloves.

SPSO1-01

Perceptual skills in badminton: fMRI indicates differences in brain activation between expert and novice players

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The purpose of the present study was to compare the brain activity of expert and novice badminton players while carrying out an anticipation task. In a

block-design, fMRI study, five national badminton players, five club players and five novices viewed 2 s visual displays of an opposing player, and pressed a button to indicate which of four possible court positions a stroke was directed. Individual trials were occluded either 80 ms before or 80 ms after the racquet-shuttle contact. Different versions of the task used either full video, or point-light stimuli, which preserved the purely kinetic cues to the opponent's action. Relative to viewing and responding to moving or stationary control stimuli, the anticipation task activated the brain's mirror network (MNS), both in the full video and point-light versions. Activations overlapped strongly for the pre-contact and post-contact occlusion conditions, but the experts showed more widespread activation in the pre-contact condition where the only cues were from the opponent's body movement, and novices in the post-contact condition in which the shuttle flight was visible. A second-level analysis of brain regions of interest showed greater activation in the MNS of expert brains (across all conditions) in the visual motion area MT/v5, and in BA45 and BA47 (inferior frontal gyrus). Also, in these areas and in the supplementary motor area (SMA) there was a significant interaction between expertise and level of occlusion, such that experts showed proportionally greater activation in the pre-contact occlusion condition. These higher activations imply that for experts, the pre-contact occlusion stimuli are strongly differentiated from control stimuli. This is consistent with MNS involvement in experts' superior ability to analyse or model the kinetic information of an opponent's body movement.

SPSO1-02

Interactive effects of challenging and supportive transformational leadership on self-confidence and resilience

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Transformational Leadership (Bass, 1985: *Leadership and performance beyond expectations*. New York: Free Press) has been positively associated with performance and potential mediating variables including self-efficacy, intrinsic motivation, trust and affective commitment (e.g. Podsakoff *et al.*, 1990: *Leadership Quarterly*, 1, 107–142). However, research has yet to consider interactions between transformational leadership behaviours. Grounded in a framework provided by stress and social support literature, the present study examined interactions between challenging and supportive transformational leadership

behaviours on self-confidence and resilience. Specifically, it was hypothesised that there would be significant interactions between the challenge behaviours high performance expectations and intellectual stimulation, and the supportive behaviours individual consideration, appropriate role model, and contingent-reward. It was anticipated that high levels of challenge would have detrimental effects on resilience and self-confidence if support behaviours were low, and beneficial effects when support behaviours were high.

Following institutional ethics approval, 352 male infantry recruits (mean age = 19.96, $s = 2.56$) completed Hardy *et al.*'s (in press: *Leadership Quarterly*) leadership scale, and measures of self-confidence and resilience. All transformational leadership behaviours were significantly positively associated with self-confidence and resilience. Furthermore, moderated hierarchical regression analyses revealed that of twelve interactions tested, nine were significant and displayed a consistent pattern of effects in line with *a priori* hypotheses. For example, when regressed on self-confidence, the interaction between intellectual stimulation and appropriate role model explained significant additional variance ($\Delta R^2 = 0.061$; $P = 0.000$); furthermore, *t* tests for the significance of the simple slopes confirmed a positive regression line at high levels of appropriate role model ($t = 2.777$, $P = 0.006$) and a negative regression line at low levels of appropriate role model ($t = -2.873$, $P = 0.004$) (See Figure 1).

A key implication of these findings regarding the application and development of transformational leadership is the need to ensure that high performance expectations and intellectual stimulation are not increased without complementary increases in support behaviours. Furthermore, highest confidence and resilience levels are reported when high levels of both challenge and support behaviours are present, and the study provides additional evidence for the beneficial effects of transformational leader-

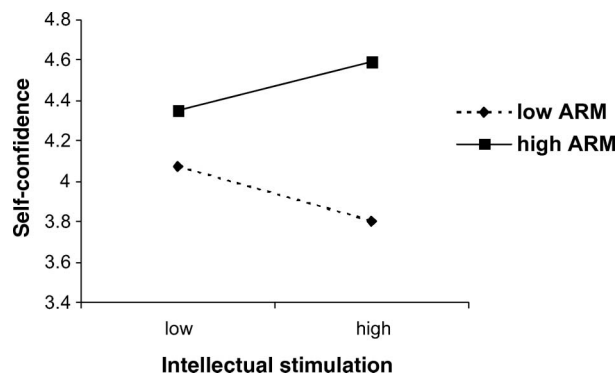


Figure 1. Interaction between intellectual stimulation and appropriate role model predicting self-confidence.

ship. It is suggested that in the sporting domain, these findings have relevance to any leadership position (e.g. coaches, managers and performance directors).

SPSO1-03

Self-efficacy and performance catastrophes: A test of engagement versus disengagement

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Hardy's (1990) cusp catastrophe model of anxiety and performance attempts to explain the interactive effects of cognitive anxiety and physiological arousal upon performance. The main interest in the model is that when cognitive anxiety is high, increasing levels of physiological arousal will lead to a sudden and dramatic drop in performance. When this occurs, a large reduction in physiological arousal is required before performance springs back to the upper surface. This horizontal displacement is termed *hysteresis* (Hardy & Parfitt, 1991: *British Journal of Psychology*, 82, 163–178; Hardy, Parfitt, & Pates, 1994: *Journal of Sports Sciences*, 12, 327–334).

Hardy, Beattie and Woodman (2007: *British Journal of Psychology*, 98, 15–38) further explored the hysteresis hypothesis in the context of processing efficiency theory (Eysenck & Calvo, 1992: *Cognition and Emotion*, 6, 409–434). Results supported their hypothesis in that previous tests of the hysteresis effect may have been due to a complex interaction between cognitive anxiety and effort required (task difficulty). By using task difficulty as an asymmetry factor a further catastrophe model may be tested where a complex interaction may occur due between task difficulty and self-efficacy (Bandura, 1986: *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ, Prentice-Hall.). As previous research has shown that task engagement tends to increase as self-efficacy beliefs increase (Caraway *et al.*, 2003: *Psychology in Schools*, 40, 417–427), the purpose of the present study was to explore the hysteresis hypothesis in terms of possible interactive effects between task difficulty and self-efficacy upon engagement and disengagement of a motor task. It is hypothesised that hysteresis will occur upon task engagement in the low self-efficacy condition but not in the high self-efficacy condition.

Sixty one volunteers (mean age 21.07 years, $s = 1.27$) participated in the study. Participants completed a measure of self-efficacy in regards to successfully passing a rugby ball 10 times through 5 different target holes that ranged in difficulty (i.e. they reduced in size). Half the participants com-

pleted the task in a task difficulty increasing to decreasing condition (level 1 to 5 to 1); the other half completed the task in reverse order. Participants were told they would gain one point for a successful attempt but lose one point for an unsuccessful attempt. The person with the highest score at the end of the session would win a cash prize.

Results revealed a significant three-way interaction between self-efficacy (High versus Low), direction (Inc versus Dec), and level (1–5) upon attempts made ($F(4, 56) = 11.7$, $P < 0.01$; $\eta^2 = 0.456$). Follow up test revealed that hysteresis did occur in the low self-efficacy condition but not in the high self-efficacy condition.

SPSO1-04

Determining cue areas for visual perception of the attacking action in Spanish national level fencers

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It seems to be crucial for elite fencers to determine the point on which they have to focus their sight in order to obtain the best information about the location and movements of the attacker. This aspect has not been clarified yet and it has high variability even among fencers of the same training group.

Following a methodology similar to that used by Ripoll *et al.* with members of the boxing French team (1995: *Human Movement Science*, 14, 325–349), we tried to determine the area that provides fencers with the most relevant information about the attacker's action.

Seventeen fencers of the Spanish national team (Age 25.5, $s = 4.8$ years) carried out a protocol developed on SuperLab 4.0 (Cedrus, San Pedro, CA, USA), in which real sized videos of a fencer attacking “up-right”, “up-left”, “down-right” and “down-left” were projected onto a 3×2 m screen under five different visual conditions: “weapon occlusion” (WO), “hand-guard occlusion” (HGO), “legs occlusion” (LO), “only hand-guard vision” (HGV) and “complete vision” (CV). After eight training trials, each fencer had to complete a 60-trials protocol (three trials \times four attacking directions \times five visual conditions) before finishing the test.

Time to the decision-making since the starting of the attacker movement (TDM) and number of errors (E) were integrated into the attack perception coefficient $[APC = (3 - E) \times (1/TDM) \times 100]$ for every attacking direction and visual condition.

Our results showed that the best results on attack perception were obtained under CV (APC 0.49, $s = 0.16$) followed by LO (APC 0.45, $s = 0.12$) and HGO (APC 0.42, $s = 0.12$) conditions and the worst were for WO (APC 0.38, $s = 0.11$) and HGV (APC 0.32, $s = 0.15$) conditions. An ANOVA ($F_{4,335} = 14.58$, $P < 0.01$) and the Tukey's post-hoc test pointed out significant differences for the APC between CV and WO ($P < 0.01$) and HGV ($P < 0.01$) but not between CV and HGO ($P = 0.06$) and LO ($P = 0.53$).

We conclude that legs and hand-guard are not as relevant as blade's information for the perception of the attacking action in fencing. We propose focusing the sight on a fix point of the trunk (i.e. armed shoulder) to get accurate information about the opponent distance, and keeping the attention on the blade into our peripheral visual field, which is specialised on movement perception.

SPSO1-05

A temporal examination of elite performers' sources of sport-confidence

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According to Vealey *et al.* (1998: *Journal of Sport & Exercise Psychology*, 20, 54–80) athlete's sport-confidence beliefs are derived from nine sources of information. Specifically, sources associated with mastery; demonstration of ability; physical/mental preparation; physical self-presentation; social support; coach's leadership; vicarious experience; environmental comfort and situational favourableness. The stability of sport-confidence over time is proposed to be a function of the sources upon which individuals base their beliefs (Vealey *et al.*, 1998: *Journal of Sport & Exercise Psychology*, 20, 54–80). However, it is unclear whether these sources fluctuate or remain stable throughout the time preceding competition. This study examined whether the sources of sport-confidence experienced by elite athletes remained constant during the build-up to a major competition.

Following institutional ethical approval, 53 elite individual athletes currently competing at an international level (male, $n = 29$, mean age 24.9, $s = 7.0$; female, $n = 24$, mean age 24.1, $s = 7.2$) completed the Sources of Sport-Confidence Questionnaire (SSCQ: Vealey *et al.*, 1998: *Journal of Sport & Exercise Psychology*, 20, 54–80) at five precompetition phases (6 weeks, 4 weeks, 3 weeks, 2 weeks and 1 week until competition). The instructional set for the SSCQ was modified to assess the importance of each

item in relation to their upcoming competition at that specific time.

A two-factor (time-to-competition \times gender) MANOVA revealed no significant interactions, but highlighted main effects for both time-to-competition (Pillai's trace = 0.836, $P < 0.05$) and gender (Pillai's trace = 0.362, $P < 0.05$). Significant differences indicated that females perceived mastery, physical self-presentation, social support, environmental comfort and coach's leadership as more important sources than males. Further, significant time-to-competition effects showed that demonstration of ability, physical/mental preparation, physical self-presentation and situational favourableness were more salient to elite athletes closer to competition than further away. In contrast, the reliance placed upon mastery, social support, vicarious experience, environmental comfort and coach's leadership remained stable throughout the time preceding competition.

Results showed that the importance placed upon specific sources of sport-confidence fluctuated in the build-up to a major competition. From a practical perspective, coaches and practitioners should continue to facilitate these sources throughout the pre-competition period but ensure their availability closer to performance. Gender findings suggested that elite female athlete's more so than males, would benefit from an environment which provides more opportunities to master skills are socially supportive yet remains challenging. Future research should examine the perceived underlying mechanisms that underpin the gender and time-to-competition findings.

SPSO1-06

A qualitative examination of athletes' perceptions of sport psychology consultant effectiveness based on physical characteristics

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First impressions formed by sports performers are reported to influence their judgements about the expected effectiveness of the sport psychology consultant (SPC) (Lubker *et al.*, 2005: *The Sport Psychologist*, 19, 446–458). Research suggests that appearance and specifically dress and/or body shape are key variables in athletes' initial efficacy expectations of the SPC (Lubker *et al.*, 2005: *The Sport Psychologist*, 19, 446–458, and Lovell *et al.*, 2008: British Psychological Society Annual Conference, Dublin, April). The purpose of this research was to extend the research by Lovell *et al.* (2008) by

exploring the reasons why performers consider different physical characteristics of SPCs salient when forming efficacy expectations.

Performers ($n = 233$, mean age = 20.16, SD = 2.94 years) all participating in regular competitive sport, (male, $n = 133$, or female, $n = 100$; elite/sub-elite, $n = 158$, or club/recreational, $n = 75$) ranked images of SPC's in order of their preference to work with them and rated the SPC's effectiveness. Participants were then asked to describe in their own terms "*what was it about the sport psychologist that shaped your rankings and perceptions of effectiveness?*"

Responses were content analysed to identify meaning units and construct emergent themes. No gender or competitive level trends emerged. For the majority of performers the SPC's body size (BMI) and specifically slimness, was very clearly and consistently associated with performers' perceptions of the SPC's: likely sport involvement; attractiveness; mental and physical health; desirable personal qualities, and role effectiveness. Looking "sporty" was associated with participation in and/or a good understanding of sport. This in turn was associated with perceptions of the SPC having a better understanding of the athlete's experience and being more able to help the performer. Two distinct trends emerged regarding dress. Formal clothing was associated with professionalism and qualities of intelligence and competence. Whereas casually dressed SPCs were attributed with qualities such as being approachable, friendly and interested in sport.

Implications of these findings suggest SPCs should consider their physical appearance when meeting with sports performers. This relationship is likely to be complex, including factors such as context and location of meeting, relative age difference, expected social etiquette and physique associated with the client's sport.

SPSHO1-01

The Yo-Yo intermittent endurance test: Reproducibility, relationship to match performance, positional and seasonal differences in elite senior soccer player

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The Yo-Yo intermittent tests assess the capacity to carry out progressive intensity intermittent exercise

leading to a maximal activation of the aerobic system. Previous research has examined the Yo-Yo intermittent recovery test and its application to elite soccer. However, limited research exists concerning the Yo-Yo intermittent endurance test level 2 (Yo-Yo IE2) and whether it is a sensitive tool to evaluate the intense intermittent exercise performance of elite soccer players. Therefore, the aims of this study were to (1) determine the Yo-Yo IE2 test's reproducibility, (2) assess the relationship between the Yo-Yo IE2 test and match performance and (3) quantify the sensitivity of the Yo-Yo IE2 test to detect test-retest changes and discriminate between performance for different playing positions.

With institutional approval, 34 English FA Premier League soccer players (mean age 26, $s = 5$ years, height 1.83, $s = 0.04$ m, body mass 80.9, $s = 7.1$ kg) carried out the Yo-Yo IE2 test on several occasions over three consecutive seasons. The Yo-Yo IE2 test consists of repeated 20 m shuttle runs at progressively increasing speeds with a 5 s period of active recovery between shuttles. Failure to achieve the shuttle run on two successive occasions resulted in termination of the test and the distance covered was recorded and represented the test result. All testing sessions were performed indoors on an artificial surface on a 2 × 20 m running lane marked by cones. Activity profiles were quantified during competitive games using a multiple-camera computerised tracking system (ProZone Sports Ltd[®], Leeds, UK) and then averaged over the course of each season. A one-way ANOVA was used to evaluate differences between playing positions for Yo-Yo IE2 test and match performances. Relationships between selected performance variables were evaluated using Pearson's product moment test. Statistical significance was set at $P < 0.05$.

The mean distance covered in the Yo-Yo IE2 test was 2252, $s = 423$ m. Test-retest coefficient of variation in Yo-Yo IE2 test performance has previously been determined and was reported to be 3.9%. A significant correlation was observed ($P < 0.01$) between Yo-Yo IE2 test performance and the total ($r = 0.74$) and high-intensity ($r = 0.58$) running distance covered in a match. It was observed that central defenders (2000, $s = 247$ m), full-backs (2107, $s = 438$ m), wide midfielders (2302, $s = 302$ m) and central midfielders (2223, $s = 394$ m) had a higher Yo-Yo IE2 test performance ($P < 0.05$) than attackers (1786, $s = 306$ m). For a group of 15 players, the intra- and inter-season coefficient of variation for Yo-Yo IE2 test performance was 4.2 and 5.6%, respectively.

This study demonstrates that the Yo-Yo IE2 test is reproducible and can be used to quantify the capacity of elite soccer players to perform intense intermittent exercise. Furthermore, the Yo-Yo IE2 test was

shown to be a sensitive tool that not only relates to match performance but can differentiate between intermittent exercise performance of players in various stages of the season and playing positions.

SPHO1-02

Physiological characteristics of elite level mountaineers

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The aim of this study was to investigate the physiological characteristics of mountaineers prior to an expedition and whether this has an impact on perceived ability to perform at altitude.

With institutional ethics approval, 18 males and 1 female from the Army Mountaineering Association took part in the 12 month preparation period and expedition to Mt. Everest. Participants were tested for maximal oxygen uptake ($\dot{V}O_{2\max}$) using a treadmill protocol, stature, body mass and skinfold measurements (sum of skinfolds and body fat percent). Tests were carried out 12 and 3 months prior to departure for the expedition. Specific training was prescribed from the results of the tests.

Mean characteristics from the initial and the final tests prior to departure are shown in Table I.

Mean $\dot{V}O_{2\max}$ for the group increased by $5.0 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ between the initial and final tests (Table I). Sum of skinfolds and body fat percent both decreased between tests (mean 18.6, $s = 18.2 \text{ mm}$, mean 0.6, $s = 2.3\%$ respectively, Table I). Fifteen members improved $\dot{V}O_{2\max}$, and six improved sum of skinfolds and body fat percent. Changes in physiological characteristics were not significant. All members of the team reached 7600 m without use of supplementary oxygen and one reached 8150 m without supplementary oxygen.

In this expedition altitude reached (7600–8150 m) was limited by a high probability of avalanche which

ended the expedition. However, all 18 climbers were reported by the expedition leader as fit enough to attempt the physical challenge associated with attempting to summit. The leadership team considered that the fitness testing and associated training prescription resulted in the best physically prepared team they had ever been associated with. While there is no clear relationship between sea level fitness and performance at altitude, the testing and training programme produced favourable changes in endurance fitness and body composition, which were believed to have been a crucial component in preparing the team for the fitness requirements of expedition.

SPHO1-03

HIF1A genetic polymorphism and endurance performance

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Hypoxia inducible factor 1 (HIF1) is a protein that induces gene expression related to metabolism, angiogenesis and erythropoiesis. A polymorphism in the alpha subunit of the HIF1 gene (HIF1A) at position P582S, giving C/T alleles, has been associated with the response of maximal oxygen uptake ($\dot{V}O_{2\max}$) to endurance training in elderly males (Prior *et al.*, 2003: *Physiological Genomics*, 15, 20–26). Our purpose was to investigate the P582S polymorphism of HIF1alpha for association with endurance phenotypes and myosin heavy chain composition (MHC) in young women.

Untrained females (18–37 years) completed pre- and post-training assessments of two-leg cycling $\dot{V}O_{2\max}$ ($n = 59$) and one-leg cycling $\dot{V}O_{2\text{peak}}$ ($n = 51$). MHC (vastus lateralis) was assessed in 26 participants pre- and 19 post-training (18 pre- and post- training pairs). Participants trained on cycle ergometers for 45 min, 3 days/week for 6 weeks.

Table I. Physiological Characteristics expressed as mean \pm s.

		Body mass (kg)	Height (cm)	Skinfolds (mm)	Body fat (%)	$\dot{V}O_{2\max}$ ($\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$)
12 months prior to expedition	Mean	79.1	175.5	96.2	12.9	51.6
	s	11.4	7.2	38.9	5.5	6.8
3 months prior to expedition	Mean	77.5	175.7	77.6	12.2	56.6
	s	10.1	7.4	20.7	3.2	4.6
Change	Mean	−1.6	0.2	−18.6	−0.6	5.0
	s	−1.3	0.2	−18.2	−2.3	−2.2

Only one participant was TT genotype so groups of T-allele carriers (CT, $n=13$) and non-carriers (CC, $n=46$) were formed. No difference existed between genotypes for pre-training $\dot{V}O_{2\max}$ ($P=0.649$) but CT exhibited greater increases following training (302 versus 209 $L \cdot \min^{-1}$, $P=0.050$). There were no differences between genotypes for one-leg $\dot{V}O_{2\text{peak}}$ pre-training ($P=0.671$) or training-induced changes ($P=0.567$). No differences existed between genotypes for MHC before training. However, CT ($n=4$) increased type IIa MHC following training (pre-training mean 50.6 , $s=14.6\%$, post-training mean 56.3 , $s=12.4\%$, $P=0.024$), and tended to decrease type I MHC (pre-training mean 36.8 , $s=10.0\%$, post-training mean 30.9 , $s=8.6\%$, $P=0.103$). CC ($n=14$) increased type I MHC following training (pre-training mean 30.7 , $s=10.9\%$, post-training mean 35.9 , $s=8.6\%$, $P=0.035$) partly due to a non-significant decrease in type IIa MHC (pre-training mean 54.6 , $s=16.1\%$, post-training mean 49.9 , $s=8.6\%$, $P=0.329$). Therefore, a gene-environment interaction was observed, with changes in type I MHC significantly different between genotype groups ($P=0.024$).

The P582S HIF1A polymorphism was associated with the training response of $\dot{V}O_{2\max}$ but not through alterations to the limb specific aerobic capacity, thus suggesting the possibility of an erythropoietic effect. Skeletal muscle MHC was, however, affected in a genotype-specific way. HIF1A is a potential genetic influence on endurance performance but more work is needed to replicate findings and elucidate underlying mechanisms.

SPHO1-04

A six-week racewalking training intervention

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Racewalking training has received little attention in the scientific literature but is routinely recorded by coaches and athletes. Therefore the purpose of this study was to examine change in physiological variables identified before and after six weeks of racewalking training performed by male racewalkers.

Six male racewalkers volunteered for this study, which had University ethical approval. The mean pre-intervention age, height, body mass and maximum oxygen uptake were 30 , $s=9$ years; 1.77 , $s=0.02$ m; 68.4 , $s=7.3$ kg; and 60.2 , $s=6.4$ $ml \cdot kg^{-1} \cdot \min^{-1}$. A pre- and post-intervention discontinuous incremental racewalking treadmill test was undertaken to determine velocities at lactate threshold (v-LT), lactate turnpoint (vLTP) and maximum oxygen uptake ($\dot{V}O_{2\max}$) in the athletes. This data were used as the basis for a six-week training intervention, matching v-LT, v-LTP and $\dot{V}O_{2\max}$ to endurance (four $50\text{--}70$ min sessions $\cdot \text{week}^{-1}$), stamina (one 2×20 min, 5 min recovery session $\cdot \text{week}^{-1}$) and speed (one 6×4 min, 4 min recovery session $\cdot \text{week}^{-1}$) sessions. Training diaries were scrutinised to compare training prescription with training performed (Table I). Paired samples t tests measured differences in variables pre- and post-intervention. Effect size (ES: magnitude of difference between s in two variables) in this study was reported as trivial ($<0.2\%$), small ($0.2\text{--}0.6\%$), moderate ($0.6\text{--}1.2\%$) or large ($>1.2\%$).

Post-intervention v-LTP increased by 0.8 ± 0.7 $km \cdot h^{-1}$ (5.5% ; ES 0.4 = small; $P < 0.05$); and $\dot{V}O_{2\max}$ increased by 0.5 ± 0.3 $km \cdot h^{-1}$ (3.6% ; ES 2.0 = large; $P < 0.05$).

This study provides new data on training for racewalking events. Worthwhile changes in velocity at lactate turnpoint and velocity at maximum oxygen uptake were observed following the six-week training intervention, which may warrant further investigation with a larger cohort of trained racewalkers.

Table I. Six-week training intervention.

Training characteristics	Mean \pm SD
Weekly volume	50.2 ± 26.9 km
Training sessions prescribed v performed	$n = 36$ v 29 ± 8
Intervention adherence	$81 \pm 21\%$
Duration v-LT, v-LTP, v- $\dot{V}O_{2\max}$ sessions	58.0 ± 10.6 , 40.5 ± 1.2 , 20.6 ± 0.9 min
Volume v-LT, v-LTP, v- $\dot{V}O_{2\max}$ sessions	10.8 ± 2.2 , 8.6 ± 0.9 , 4.9 ± 0.6 km
Performed v prescribed v-LT sessions	11.2 ± 1.2 v 11.3 ± 1.1 ($km \cdot h^{-1}$) ^{NS}
Performed v prescribed v-LTP sessions	12.8 ± 1.2 v 12.2 ± 0.9 ($km \cdot h^{-1}$) ^{NS}
Performed v prescribed v- $\dot{V}O_{2\max}$ sessions	14.1 ± 1.4 v 13.9 ± 0.7 ($km \cdot h^{-1}$) ^{NS}

NS = No significant difference.

SPHO1-05

Running economy on the flat does not reflect economy of incline runningC. Loxston^{1,2}, M. Wilkinson¹, S. Garland², & P. Hayes¹¹*Nothumbria University, Newcastle and* ²*English Institute of Sport, London, UK*

There is limited research examining the effects of running surface incline on running economy. It is unknown whether athletes who are economical on the flat remain economical on a gradient. This is surprising as running economy is recognised as a determinant of long distance running (Conley & Krahenbuhl, 1980: *Journal of Medicine and Science in Sports and Exercise*, 12, 357-360). Accordingly, the purpose of this study was to examine the effect of changing gradient on running economy.

With institutional ethical approval 8 trained runners (age 29.1, $s=13.1$ years; stature 178.0, $s=5.7$ cm; body mass 76.9, $s=5.7$ kg), who were habituated to procedures, participated. On separate days, participants performed incremental speed tests on a motorised treadmill to assess lactate threshold and $\dot{V}O_{2\max}$ at 1 and 6% gradients. Running economy was taken as the 60-s mean of $\dot{V}O_2$ in the final minute of a four-minute stage at $8 \text{ km} \cdot \text{h}^{-1}$, a speed that was below lactate threshold for all participants on both gradients. Participants were ranked by economy on each gradient.

There was a low correlation between ranked economy on the two running gradients (Spearman's $\rho=0.4$, $P=0.34$) and the oxygen cost of running at $8 \text{ km} \cdot \text{h}^{-1}$ was higher on the 6% gradient (mean 6% 34.5, $s=4.9 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) than on the 1% gradient (mean 29.0, $s=5.1 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, $t_7=-2.71$, $P=0.04$, Cohen's d effect size = 1.1). Speed at lactate threshold was lower at the 6% than the 1% gradient (mean 8.4, $s=0.5$ and 10.1, $s=0.6 \text{ km} \cdot \text{h}^{-1}$ respectively, $t_7=7.0$, $P<0.01$, Cohen's d effect size = 2.9) but $\dot{V}O_{2\max}$ did not differ (1% mean 50.0, $s=3.6$, 6% 51.8, $s=5.5 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, $P=0.46$, Cohen's d effect size = 0.4).

The poor association in ranked economy shows that those runners most economical at 1% did not remain so at 6% and conversely some runners with poor economy at 1% improved their economy rank on the 6% gradient. Oxygen cost at a fixed speed was higher at the 6% than the 1% gradient. Despite differences in treadmill gradient, $\dot{V}O_{2\max}$ did not differ between the tests. The results suggest that running economy is specific to gradient. This has implications for predicting running performance on an undulating course.

SPHO1-06

Alterations in left ventricular function and cardiac biomarkers as a consequence of repetitive endurance cyclingK. Williams¹, W. Gregson¹, C. Robertson¹, N. Datson¹, G. Whyte¹, C. Murrell², L. Wilson², P. Ainslie², R. Shave³, Emma Rose³, D. Gaze³, & K. George¹¹*Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, UK,* ²*Department of Physiology, University of Otago, New Zealand, and* ³*Centre for Sports Medicine and Human Performance, Brunel University, West London, UK*

Recent meta-analyses have described a decrease in left ventricular (LV) systolic and diastolic function and an elevation in cardiac troponin T (cTnT) and N terminal pro B type natriuretic peptide (NTproBNP), that is representative of cardiomyocyte damage after single but prolonged bouts of physical activity. Few studies have investigated cardiac function and biomarkers after repeated bouts of prolonged endurance exercise. The aim was to assess left ventricular function and cardiac biomarkers before, during and after 21 days of repetitive endurance cycling.

Ten trained male volunteers completed the study (mean age 40.0, $s=4.5$ years, height 178.6, $s=8.5$ cm, body mass 79.4, $s=10.8$ kg, $\dot{V}O_{2\max}$ 56, $s=4 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$). Participants completed a combination of pre and post-race laboratory tests one week before the first day of cycling and 2 days after the final day of cycling. Participants completed 21 cycling stages that replicated the Tour de France (2007) route and on intermittent days post-stage assessment included collection of blood to assess cardiac biomarkers and echocardiographic scans.

Measures of systolic and diastolic function altered throughout the tour. Ejection fraction (EF) decreased significantly from pre-tour assessment (mean 70, $s=2\%$) to stage 18 (mean 57, $s=2\%$). Early/late tissue velocity ratio (E'/A') also decreased significantly ($P<0.05$) from pre-tour assessment (mean 1.66, $s=0.17$) until stage 18 (mean 1.04, $s=0.10$). Post-tour, EF and E'/A' values had almost returned to pre-tour levels. Pre-race values showed no detectable cases of cTnI. The appearance of cTnI was sporadic but peaked at stage 15 ($n=6$), with one remaining detectable case post-tour testing ($n=1$). NTproBNP values also showed significant increases ($P\leq 0.05$) across the race from the pre tour assessment value (mean 23.7, $s=5.0 \text{ pg} \cdot \text{ml}$) to a peak at stage 17 (mean 240.4, $s=144.9 \text{ pg} \cdot \text{ml}$), after which it decreased until post-tour testing (mean 49.1, $s=26.8 \text{ pg} \cdot \text{ml}$).

Both systolic and diastolic function was altered during repeated bouts of prolonged cycling. In addition to this, biomarkers of EICF were elevated at various points of the tour suggesting that some form of EICF had occurred. This data is useful for clinicians and coaches evaluating athletes with changes in cardiac structure and function following prolonged repeated bouts of endurance exercise.

SPHO2-01

Nutritional intake assessment of professional footballers: A mixed methods approach

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It is well established that good nutrition is essential for optimal performance. Most cases the athlete is required to alter their habitual eating habits to those that are sport-specific. Dietary intake is influenced by many factors including genetics, the environment, socio-economics and culture (Flatt, 1995: *American Journal of Clinical Nutrition*, 61, S952–S959). Professional footballers are regularly transferred between countries. In this situation the player may experience additional problems adapting such eating habits to the new national food or dietary pattern. Previous studies have shown that professional footballers often fail to consume the ideal sport-specific diet (Maughan, 1997: *British Journal of Sports Medicine*, 31, 45–47). However, little research has been conducted to investigate reasons why. Therefore the aim of this study is to investigate how professional footballers change normal eating habits to those that are sport-specific with reference to cultural factors.

To attain the aim of this research project, the most appropriate research methodology consists of a combination of quantitative and qualitative methods. Nutritional intake assessment was conducted with twenty-four professional football players in order to initially examine whether they consumed an adequate diet for performance. Using a 4-day food diary with household measures, energy and macronutrient intakes were assessed and compared to requirements for professional footballers (MacLaren, 2003: In *Science and soccer*, edited by T. Reilly and M. Williams. London: Routledge; Rico-Sanz, 1998: *International Journal of Sport Nutrition*, 8, 113–123). Based on the results, 33 individual interviews with both players and staff were conducted to further investigate the reasons why footballers can not change their eating habits. This approach was considered appropriate as it

would enable interviewees to use their own words to describe experiences and views.

The results of nutritional intake assessment showed that footballers in this study failed to consume a diet adequate for performance. The data obtained by interviews backed up the results of nutritional intake assessment. It is revealed that eating habits is primary related to players' upbringing. For example, some overseas players suggested that adapting themselves to the new eating environment is often more difficult than adapting themselves to the new food. Those remarks indicate that cultural barriers do exist that make the consumption of the optimal football specific diet difficult. It is hoped that these findings will be able to help fill the gap between scientific research and players and club practice.

SPHO2-02

Interaction of glucose with putative oral carbohydrate receptors does not improve performance in a simulated cycle time-trial

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Carbohydrate consumption during endurance exercise improves performance but the mechanism for this ergogenic effect is unclear in events lasting less than one hour. A maltodextrin mouth rinse improved performance in a 1-h cycling time trial, suggesting that interaction with oral carbohydrate receptors might influence central fatigue (Carter *et al.*, 2004: *Medicine and Science in Sport and Exercise*, 36, 2107–2111). However, attempts to reproduce this effect for treadmill running (Whitham & McKinney, 2007: *Journal of Sports Sciences*, 25, 1385–1392) were unsuccessful. The aim of the current study was to establish if holding glucose tablets in the mouth to maximise the duration of interaction with putative oral receptors would improve performance in a cycling time trial.

With institutional ethical approval, nine endurance trained males aged 19–55 years (mean 33.1, $s = 12.1$) completed three simulated cycle time trials to complete a work load equivalent to 45 min cycling at 75% power at $\dot{V}O_{2max}$. Prior to each time trial participants fasted for a minimum of 4 h and completed a 15 min cycle at 65% of power at $\dot{V}O_{2max}$ to further deplete hepatic glycogen stores and blood glucose. During the first time trial participants consumed a flavoured placebo (total of 13 ml \times body mass (kg) in 5 doses). During the

second and third time trials participants either consumed a similar volume of flavoured solution containing 31 g (10) dissolved glucose tablets or held glucose tablets in their mouths throughout, two at a time for each 15 min period to a total of 10, swallowing any residue.

Performance time was not significantly different between placebo (50 ± 7.6 min), liquid carbohydrate (47.4 ± 5.7 min) or solid carbohydrate (48.74 ± 5.35 min) trials. There was no effect of either mode of carbohydrate administration on performance in Baddeley reasoning tests, or in ratings of perceived exertion throughout the time trials.

These results suggest that there is minimal ergogenic effect of this relatively low dose of carbohydrate feeding on cycle time trial performance. Furthermore, there is no evidence that prolonged interaction of carbohydrate with putative oral receptors influences perception of effort or performance in a test of cognition. Taken together, these findings do not support a role for oral carbohydrate receptors in the amelioration of central fatigue.

SPHO2-04

Respiratory responses in Paralympic athletes with cervical spinal cord injury

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Lower cervical spinal cord injury (CSCI) causes complete paralysis of the intercostal and abdominal muscles. The consequent reduction in respiratory capacity may contribute to exercise limitation. No study has specifically investigated the respiratory responses to exercise in athletes with CSCI. Thus, our aim was to quantify the respiratory responses to maximal incremental arm exercise in athletes with CSCI.

With ethical approval and written informed consent, 11 GB Paralympic wheelchair rugby players with CSCI (C5-C7) completed maximal incremental arm-cranking exercise (5 W every 2 min). Static and dynamic lung volumes (spirometry), airway resistance (impulse oscillometry) and respiratory muscle strength (maximal inspiratory and expiratory mouth pressures; MIP and MEP) were assessed before and up to 30 min after exercise. Ventilatory and pulmonary gas exchange indices were assessed using an online system (Oxycon Pro). Ratings of perceived exertion (RPE) for arm discomfort and dyspnoea were assessed using Borg's CR10 scale. Statistical significance was set at $p < 0.05$.

Based on European Respiratory Society guidelines there was evidence of pulmonary restriction in 4 of the 11 participants (VC mean 83, $s = 10\%$ of predicted). None of the participants were obstructed (FEV_1/VC mean 99, $s = 9\%$ of predicted) and impulse oscillometry values were normal (airway resistance mean 0.30, $s = 0.07$ kPa \cdot s \cdot L $^{-1}$). Inspiratory muscle strength was not different compared with predicted values (MIP mean 126, $s = 30$ versus 110, $s = 16$ cmH $_2$ O; $p = 0.09$), but expiratory muscle strength was significantly lower than predicted (MEP mean 80, $s = 40$ versus 127, $s = 15$ cmH $_2$ O; $p = 0.001$). The $\dot{V}O_2$ at peak power was lower than predicted for able-bodied individuals (mean 17.1, $s = 4.8$ versus mean 22.1, $s = 5$ ml \cdot kg $^{-1} \cdot$ min $^{-1}$; $p = 0.0002$) but higher than values previously reported for athletes with CSCI.

Participants showed no signs of respiratory constraint during exercise (ratio of peak ventilation to maximum voluntary ventilation: 37, $s = 14\%$; ratio of peak tidal volume to vital capacity: mean 23.6, $s = 4.6\%$). Consequently, ventilation for a given metabolic demand was appropriate (i.e., $P_{ET}CO_2$ values were < 40 mmHg, oxygen saturation near resting values). At end-exercise, RPE was higher for arm discomfort versus dyspnoea (mean 8.2, $s = 1.3$ versus mean 6.1, $s = 2$; $p = 0.007$). Exercise did not elicit respiratory muscle fatigue, as evidenced by nonsignificant changes in respiratory muscle strength and lung function from pre- to post-exercise.

Despite evidence of pulmonary restriction and expiratory muscle weakness, the respiratory system appears to have adequate reserve to cope with the demands placed on it during maximal incremental exercise in athletes with CSCI.

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SPHO2-05

The diaphragm does not fatigue in response to sustained, high-intensity exercise in Paralympic athletes with cervical spinal cord injury

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Previous research has suggested that the diaphragm fatigues during sustained arm-cranking exercise in patients with cervical spinal cord injury (CSCI), as demonstrated by a progressive decrease in the centre

frequency of the diaphragm electromyogram (Sinderby *et al.*, 1996: *Spinal Cord*, 34, 594–601). The validity of this technique, however, has been questioned. Thus, using direct nerve stimulation techniques we aimed to determine whether the diaphragm fatigues in response to high-intensity arm-cranking exercise in athletes with CSCI.

After institutional ethics approval and written informed consent, eight GB Paralympic wheelchair rugby players (peak oxygen uptake = 17.2, $s = 5.2$ ml·kg⁻¹·min⁻¹) with CSCI (C5–C7) performed arm-cranking exercise to the limit of tolerance at 90% of peak aerobic power. Diaphragm contractility was assessed before and up to 30 min after exercise by measuring the potentiated twitch transdiaphragmatic pressure ($P_{di,tw}$) response to supramaximal magnetic stimulation of the phrenic nerves. Maximal inspiratory mouth pressure (MIP) was also assessed before and after exercise. Ventilatory indices were assessed throughout exercise using an ultrasonic flow transducer. Ratings of perceived exertion (RPE) for arm-discomfort and dyspnoea were assessed every 2 min using Borg's CR10 scale.

Participants exercised at 53, $s = 18$ W for 8.9, $s = 8.1$ min. There was no difference pre- versus post-exercise for $P_{di,tw}$ (27.3, $s = 6.2$ versus 26.4, $s = 6.1$ cmH₂O; $p > 0.05$) or MIP (121, $s = 30$ versus 121, $s = 34$; $p > 0.05$). Minute ventilation rose throughout exercise and reached 61, $s = 12$ L·min⁻¹ at end-exercise. Tidal volume was unchanged from the first to the last minute of exercise (0.93, $s = 0.29$ L versus 1.01, $s = 0.27$ L; $p > 0.05$), whereas respiratory frequency increased from minute 1 to end-exercise (49, $s = 6$ versus 58, $s = 11$ breaths·min⁻¹; $p < 0.05$). End-expiratory lung volume (EELV) and end-inspiratory lung volume (EILV) increased from baseline to the second minute of exercise, and remained above baseline values through to end-exercise (EELV 30, $s = 9$ versus 47, $s = 10\%$ of FVC; 46, $s = 16$ versus 65, $s = 22\%$ of FVC). Arterial oxygen saturation did not change from baseline to end-exercise (98, $s = 2$ versus 96, $s = 2\%$; $p > 0.05$). At end-exercise, five participants rated arm-discomfort higher than dyspnoea, one rated dyspnoea higher than arm-discomfort, and one rated dyspnoea and arm-discomfort equally.

Despite evidence of tachypnoea and dynamic lung hyperinflation, the diaphragm did not fatigue in response to sustained, high-intensity exercise in athletes with CSCI.

Acknowledgement

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SPHO2-06

Sleep analysis via actigraphy reveals five full days are required for circadian resynchronisation in elite divers crossing eight time zones

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Elite divers require precision of movement and highly developed spatial awareness, both of which can be negatively affected by sleep loss. Sleep disruptions associated with travel across multiple time zones may therefore have a detrimental effect on diving performance. This study aimed to assess the extent to which sleep parameters were disrupted following travel crossing eight time zones.

Six male (mean age 23.3 years, $s = 5.8$) and nine female (mean age 22.1 years, $s = 3.8$) divers, who were current members of the British Olympic diving squad were monitored using actigraphy watches (Cambridge Neurotechnology Ltd) and sleep questionnaires over a 20 day period including: 10 days in their home environment, 4 days during a pre-departure camp and 6 days post travel from Great Britain to China. Sleep parameters including sleep quantity (hrs:min), percent time sleeping whilst in bed (sleep efficiency; %) and fragmentation index (sleep restlessness) were assessed.

The severity of perceived jet lag peaked on the second full day (4.7/10, $s = 2.2$) and took five full days ($s = 1$) for eradication of all symptoms. Mean sleep quantity during travel to China was 03:17 h ($s = 02:03$). Variability in sleep quantity during the first four nights in China (08:27 h, $s = 01:05$; 07:00 h, $s = 01:55$; 06:47 h, $s = 01:10$ and 06:02 h, $s = 01:18$, respectively) revealed that sleeping patterns were extensively disrupted but resembled home averages (06:57 h, $s = 00:34$) from the fifth night onwards.

Athletes mean perceived sleep quantity via questionnaire (08:00 h, $s = 01:26$) was significantly higher than the sleep quantity from actigraphy (07:05 h, $s = 01:06$; $P < 0.01$). There was no relationship between aeroplane sleep quantity and time to overcome perceptions of "jet lag" ($r^2 = 0.10$) or peak severity of jet lag ($r^2 = 0.00$).

The use of objective actigraphy data revealed that athletes underestimate sleep quantity. Therefore, subjective perceptions of sleep quantity should be analysed with caution because athletes may be unaware of accumulating sleep debt. When planning future travel to destinations crossing eight time zones, 5 ($s = 1$) days are required on average to

overcome the perceptions of jet lag. However, a strong individual response exists to circadian desynchronisation therefore acclimatisation strategies should be planned on an individual basis.

SPSO2-01

There is an “I” in “TEAM”: Narcissism and social loafing

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Social loafing (Latané *et al.*, 1979: *Journal of Personality & Social Psychology*, 37, 822–832) is a reduction in individual effort when working on a team task. However, there is little evidence of any personality trait that might be more closely associated with it. As narcissists are self-focused and perform better when there is an opportunity for personal glory (Wallace & Baumeister, 2002: *Journal of Personality & Social Psychology*, 82, 819–834), they are more likely to engage in social loafing. Consequently, in line with Wallace and Baumeister’s cognitive task, we hypothesise that narcissists will engage in social loafing behaviours when their performance is not identifiable or publicised.

After completing consent forms, demographic forms, and a measure of narcissism, participants warmed up and completed a 10-minute maximum cycling task in teams of three (each ergometer was isolated via opaque screens). Participants performed the task twice: once after hearing low identifiability instructions, *we will record only the group’s overall performance*; once after hearing high identifiability instructions, *we will record the group’s overall performance but we will also record and publicise (on notice boards and on the Intranet) your individual performance within the team*. Participants wore a heart rate monitor throughout. Order of condition was balanced. We recorded individual performance for each condition.

For *performance*, a 2 (group: high/low narcissism) \times 2 (identifiability: high/low) mixed-model ANOVA with repeated measures on the second factor yielded no significant main effect for group, $F(1, 40) = 0.01$, a significant main effect for identifiability, $F(1, 40) = 5.59$, $P < 0.05$, $\eta^2 = 0.12$, and a significant group \times performance setting interaction, $F(1, 40) = 4.09$, $P < 0.05$, $\eta^2 = 0.09$. Tukey’s follow-up tests revealed a significant decrease in performance from high to low identifiable conditions for high narcissists only.

For *heart rate*, there was a significant main effect for time only, $F(1, 40) = 7.15$, $P < 0.05$: partici-

pants’ heart rate was significantly more elevated in the high identifiable condition.

Narcissists are social loafers. However, their relatively poor within-team performance is not simply a withdrawal of physical effort. Consequently, future research would do well to investigate the precise mechanisms underlying this phenomenon. The applied implication is clear: there is an “I” in “team”, for some.

SPSO2-02

A qualitative study into the “lived experience” of ultra marathon athletes

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The purpose of the study was to explore by retrospective account the psychological and emotional “lived experience” of athletes who completed The North Face Ultra Trail Tour du Mont Blanc 2007, a 163 km single-stage ultra marathon around Mont Blanc. Performance in ultra endurance events is a function of the athlete’s physical ability and tolerance of discomfort associated with extreme physical effort (Morgan & Pollock, 1997: *Psychological characteristics of the elite distance runner*, *New York Annals Academy of Sciences*, 301, 382–403), and psychological factors have an important role in ultra marathon performance (Tharion *et al.*, 1988: *Journal of Sport & Exercise Psychology*, 20, 229–235).

Participants were purposively selected information rich subjects ($N = 3$, mean age 42.6, $SD = 12.8$, Mean Running experience 18.3years, $SD = 13.5$). Following informed consent being granted, in line with university ethical research guidelines, experiences were explored using semi-structured interview and adapted IZOF emotional checklist (Hanin, 2000: *Emotions in Sport*, Human Kinetics). A specifically constructed mind mapping retrospective route chart was employed to elucidate vividness and intensity of psychological and emotional experience. Semi structured interviews were conducted, tape recorded and all interviews transcribed verbatim with the data analysed using Interpretative Phenomenological Analysis. Trustworthiness techniques included referential adequacy, member checking, thick description and peer de-briefing.

Results demonstrate commonalities between psychological and emotional experiences; however, individual differences were identified due to the periodic nature of the event with runners experiencing “critical phases” dominated by a range of high positive (helpful) emotions such as happy, confident, thrilled, inspired, determined, resolute and pleased

(mean = 74%) and low negative (harmful) emotions such as apprehension, anxiety, worry, strained, sluggish, tired, painful, uneasy, stressed (mean = 26%). Affective state patterns showed a positive-negative-positive emotional profile during the duration of the event. The athletes' ability to cope effectively with these events emerged as being "crucial" for personal success and satisfaction. Salient psychological themes emerged as important within the lived experience such as the requirement for the display of "mental toughness", "positive attitude", "self-belief and efficacy of performance accomplishments", "event enjoyment", "astute goal-setting", "pain tolerance" and "motivation for participation", which all incorporated various sub-themes common to the three participants. Findings show that the "lived experience" is both individually determined as unique from a psychological and emotional perspective but common themes are also present across group profiles.

SPSO2-03

The psychology of competing in the flying kilometre-unexplored cognitions and emotions

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The "Flying Kilometre" (FK) is the world's fastest ski race with athletes capable of recording speeds in excess of 250 kph/155 mph. Research into the pre-race mental and emotional states (<5 mins to race time) of elite FK ski racers is unexplored. This investigation explored retrospective thoughts and emotions of seven purposively selected elite skiers (three female, four male; mean age = 31.14 years/SD 5.5 years; mean FK experience = 7.4 years/SD = 3.8), by use of psychological feelings inventory (adapted from Hanin, 2000: *Emotions in Sport*, Human Kinetics), and semi structured interview. A dual method layered approach which examined cognitive and affective responses produced both quantitative and qualitative data for analysis. The affective states were initially examined for levels of intensity by psychological feelings inventory and further explored via SSI for more meaningful information related to the nature of the emotive experience.

Findings demonstrate that positive emotions dominated negative emotions pre race. The cohort reported profiles which contained high confidence and alertness, inner calm and determination, being moderately relaxed, at ease and tranquil. They reported a feeling of being courageous but not over excited or stimulated as levels of vigour and feelings

of exhilaration were reported low. Athletes reported experiencing feelings of nervous tension and being under pressure and a minor element of fear. Profiles indicated a lack of negativity, absence of doubt, anxiety, uncertainty, low concern, apprehension and low indecisiveness. Athletes reported they positively embraced the event, were not scared but thoroughly enjoyed racing at such speeds, which provided the main motive for competing. Individual profiles reported variations to the mean for highest performing athletes in both positive and negative states indicating a superior profile exists.

Cognitive activity during the race was linked to intense attention processing directed at technical aspects of body position (kinaesthetic feedback) and auditory reduction of wind resistance. Athletes reported "auto-pilot states" and an awareness of "not thinking but doing" whilst descending. Over thinking was considered extremely dangerous and was reported to have influenced previous falls of participants. Visual processing was reported as minimal at the expense of "feeling the track" and having moment by moment reactions/responses to changes in the terrain. The findings provide the first evidence on the cognitive and affective states of participants in the extreme high risk sporting environment of downhill speed skiing.

SPSO2-04

The effects of an acute bout of aerobic exercise on short term memory and concentration in older adults

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According to Grady and Craik (2000: *Current Opinion in Neurobiology*, 10, 224-231) humans exhibit losses in their memory with age. Maintaining ones cognitive functions in later life is imperative to the quality of life. Declines in cognitive function have been recognised as a key factor in nursing home entry (McCauley *et al.*, 2004: *Brain, Behaviour and Immunity*, 18, 214-220). Regular exercise and physical activity are noteworthy and effective methods in prevention and treatment of certain health problems in older adults. The primary aim of the present study was to investigate the effects of an acute bout of aerobic exercise on short term memory and concentration in older adults. A secondary aim of this study was to observe if any differences were present between men and women in the two cognitive functions tested.

Following ethical approval and a pilot study, both male ($n = 7$) and female ($n = 8$) participants were

involved in this study. The participants involved ranged between 63 and 75 years of age. A concentration grid and a word list short-term memory test were used. As the participants of the present study were acting as their own control group, a cross over design was used. Participants were tested before and after 40 min of light aerobic activity and also before and after no physical activity. Paired *t* test was used to analyse the data for short term memory and concentration. An Independent *t* test was also used in order to analyse the data retrieved from both the cross over and men compared to women in all eight tests.

There was a significant difference in short term memory following exercise ($P=0.000$). No significant difference was found in the exercise group for concentration ($P=0.294$). There was also no significant difference between men and women in any of the eight tests completed. No significant differences were found in any of the eight tests between the exercise and control groups, which reveal that there was no lingering effect.

The results of this study propose that an acute bout of aerobic exercise has a significant positive effect on short-term memory in older adults. More interventions are needed examining these effects in a more clinical setting, also many theories, both physiological and psychological exist in relation to the mechanisms involved in the improved functions, more research is needed to investigate these theories.

SPSO2-06

Delivering sport psychology workshops in Iran

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This is a reflection on my experiences in preparing and delivering a two-day programme of sport psychology workshops, in association with the Islamic Federation of Women's Sport (IFWS), the British Council, Azad University in Tehran and my own institution. Gibbs' (1994) six steps to reflective practice were employed throughout the review process.

The workshops were delivered in Tehran to delegates comprising of coaches of national teams in the Middle East, and MA Physical Education students in Tehran. The objectives were prescribed by the IFWS; "Acquaintance with psychology and its role in success in athletic performance and sports teams", "Roles and duties of a sport psychologist", "Relationships and working practices", "Methods of consultancy" and "Assessment". My initial thoughts focussed on the preparation of appropriate material and the need for extensive research on Islamic law

and customs, behaviour expectancy, sport in Iran and the IFWS. In consultation with the second author content was carefully selected and prepared. Prior to departure, I was aware I held media-driven pre-conceptions of Iran and its people, and the cultural climate I was entering. Consequently, I was anxious about my ability to meet the delegates' needs and expectations.

On reflection, the considerable time spent researching proved to be of great advantage as the use of "local" images and familiar case studies facilitated engagement between delegates and the material. Concerns over the language barrier were instantly confirmed, but thanks to the full-time support of a simultaneous translator, these were soon dispelled.

Feedback was gained through three mediums; frequent informal discussions with delegates, an anonymous post-event questionnaire, and e-mail communication with the British Council and IFWS. Positive feedback was received relating to both delivery style and content. The delegates' enthusiasm to learn and eagerness to share their experiences was an unexpected benefit to proceedings.

In conclusion, this experience provided a tremendous opportunity to develop both my professional skills as an educator and my cultural knowledge. My self-confidence and ability to adapt under pressure were frequently tested. I learnt that the unique challenges faced by Iranian women in sport, such as the theocratic regime and restrictive dress, are combined with an abundance of issues that mirror those experienced by women in the UK, and that the desire for a "quick-fix" approach to sport psychology is a global phenomenon.

HPHO1-01

Intracellular DNA oxidation by systemic oxygen-centered free radicals following incremental exercise

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It is accepted that strenuous exercise leads to an increase in reactive oxygen species capable of inducing cellular damage. Free radicals are produced

through a number of mechanisms during exercise and increased mitochondrial electron leakage has often been cited as the main source. Exercise intensity plays a key role in the activation of other related mechanisms such as substrate autoxidation, xanthine oxidase, intracellular calcium overload and NADPH oxidase. This study tested the hypothesis that incremental high intensity exercise can produce free radicals which may subsequently cause damage to DNA, lipids and proteins. The primary purpose of this investigation was to examine the effect of an acute bout of aerobic exercise on free radical generation and corresponding macromolecular damage.

Following ethical approval, 12 apparently healthy male participants (Age mean 23, $s=4$ years, stature mean 181 $s=8$ cm, body mass mean 80 $s=9$ kg and $\dot{V}O_{2\max}$ mean 49 $s=5$ ml \cdot kg⁻¹ \cdot min⁻¹) performed three, five minute stages (40, 70 and 100% of $\dot{V}O_{2\max}$) of aerobic exercise, blood was drawn for the determination of *ex vivo* free radicals (detected using electron paramagnetic resonance spectroscopy in combination with the spin trap α -phenyl-tert-butyl nitron (PBN), DNA damage, protein carbonyls, lipid hydroperoxides and lipid soluble antioxidants. Experimental data were compared using a one-way analysis of variance (ANOVA) with a. Rest and exercise data (PBN-adduct only) were analysed using a paired samples *t* test. All samples were corrected for a possible exercise-induced haemoconcentration.

Lipid derived oxygen-centred free radicals were identified (PBN-adduct hyperfine coupling constants $a_{\text{Nitrogen}}=13.7$ Gauss (G) and $a_{\beta\text{Hydrogen}}=1.8$ G) increased from rest to exercise ($P<0.05$), while DNA damage was observed from 40 to 100% $\dot{V}O_{2\max}$ ($P<0.05$). Systemic changes were observed in lipid hydroperoxide concentration and for the main lipid soluble antioxidants throughout exercise ($P<0.05$), however there were no observed change in protein oxidation ($P>0.05$).

Previous work from our laboratory has demonstrated an increased susceptibility to DNA oxidation following a single bout of exhaustive exercise (Davison *et al.*, 2005: *International Journal of Sport Nutrition and Exercise Metabolism*, 15, 480–492), and this damage was attributed to a potential increase in systemic free radicals. The present study suggests that DNA oxidation following exhaustive exercise may be related to the production of lipid-derived free radicals. The presence of lipid hydroperoxides further suggests exercise-induced damage to cell membranes.

These findings identify lipid derived free radical species as possible contributors to DNA damage in the human exercising model.

HPHO1-02

Evidence for elevated vascular shear stress following exercise in the morning

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The vascular endothelium plays an important role in the maintenance of vascular health, the modulation of vascular tone and blood pressure (BP) and is essential for vasodilation in response to increases in blood flow and associated shear stress (Pyke & Tschakovsky, 2005: *Journal of Physiology*, 568, 357–369). Endothelium-dependent vasodilation has been shown to be reduced in the early morning (Otto *et al.*, 2004: *Circulation*, 109, 2507–2510). We recently demonstrated that BP reactivity to physical activity is greater in the morning (Jones *et al.*, 2006: *Hypertension*, 47, 778–784), but no studies have examined whether differences exist in vascular responses with time of day. It is possible that diurnal variation in vascular function may contribute to elevated cardiovascular risk evident in the morning hours. Therefore, the aim of this study was to assess vascular responses following exercise at different times of day.

Following ethical approval, 12 male normotensives (Age mean=26, $s=4$ years) completed a 30-min bout of cycling at 70% $\dot{V}O_{2\text{peak}}$ on separate days beginning at 08:00 or 16:00 h. Exercise was performed after 45-min supine rest. Edge-detection and wall tracking of high resolution arterial B-mode ultrasound images combined with synchronised Doppler waveform analysis were used to measure brachial and femoral conduit artery diameter and to calculate blood flow and shear rate continuously across the cardiac cycle. Mean arterial blood pressure (MAP) and vascular measurements were recorded before, and for 20-min after, exercise. Changes from pre-exercise baseline were calculated. Data were analysed using a two factor (time of day \times post-exercise time) general linear model.

Post-exercise brachial shear rate was highest in the morning (interaction between time of day and post-exercise time: $P=0.05$). The mean $\pm s$ differences between times of day were 72 ± 78 AU at 5-min post-exercise and 1 ± 99 AU at 20-min post-exercise. This increase in shear was not compensated for by enlargement of brachial arterial diameter ($P=0.59$). No time of day differences were observed

in the femoral artery ($P > 0.14$). Post-exercise MAP was also highest in the morning ($P = 0.03$; 90% CI -16 to -2 mmHg).

This data suggests that greater shear stress is evident following morning exercise in arteries of similar size and function to coronary arteries (Anderson *et al.*, 1995: *Journal of American College of Cardiology*, 26, 1235–1241). The combination of higher post-exercise shear rate and MAP in the morning could explain the elevated cardiovascular risk evident in the post-waking hours.

HPHO1-04

The extent to which biological risk factors mediate the association between physical activity and cardiovascular disease events

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The biological mechanisms through which physical activity lowers the risk of cardiovascular disease (CVD) are incompletely understood. Exercise training studies demonstrate modest but consistent improvements in various risk factors such as blood pressure (Cornelissen & Fagard, 2005: *Hypertension*, 46, 667–675), high density lipoprotein (HDL) cholesterol (Kodama *et al.*, 2007: *Arch Intern Med*, 167, 999–1008), C-reactive protein (CRP) and other inflammatory markers (Hamer, 2007: *Prev Med*, 44, 3–11). However, the relative contribution of these risk factors to the activity related reduction in CVD remains unclear.

In a prospective study of 7881 healthy men and women (mean age 46.4, $s = 15.6$ yrs) from the Scottish Health Survey we examined the extent to which inflammatory/haemostatic (CRP, fibrinogen), metabolic (adiposity, total and HDL cholesterol), and blood pressure factors mediate the association between physical activity and risk of CVD events. Cox proportional hazards models were used with months as the time scale to estimate the risk of CVD events by physical activity exposure. Physical activity was categorised into four groups according to current physical activity recommendations; sedentary (referent), participants who were active but not meeting guidelines, participants who met the guidelines through participating in moderate intensity activity only (≥ 150 min/wk), and those that met guidelines through participating in any vigorous activity. A total of 226 incident CVD events (64 fatal) occurred over an average follow up of 7.2 years. The lowest risks for CVD were seen in participants meeting the recommendations through undertaking vigorous activity after adjustment for age, sex,

smoking and socioeconomic group (hazard ratio = 0.47, 95% CI, 0.22–0.99). The vigorously active participants also demonstrated a better biological risk profile, for example, 59% lower levels of CRP and 17% lower prevalence rate of hypertension than the sedentary. In mediation analyses we separately added each group of risk factors into the basic model. Biological risk factors collectively explained 22.6% of the cardio-protective effects of physical activity, and inflammatory and haemostatic factors explained the largest proportion of variance (13.2%), followed by metabolic factors (9.4%), and hypertension (9.4%).

In summary, the present findings support the current physical activity guidelines for reducing the risk of CVD, although optimal protection is conferred by vigorous activity. The inverse association between physical activity and CVD risk is partly mediated by traditional and novel biological risk factors.

HPSO1-01

Qualitative investigation of professional coaches perceptions of sport psychology in relation to performance

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Research shows that sport psychology plays an instrumental part in determining levels of athletic performance, with the condition of an athletes' psychological welfare being found to impact upon performance (Durand-Bush & Salmela, 2002: *Journal of Applied Sport Psychology*, 3, 154–171). Understanding coaches' perceptions of sport psychology is an area that has received widespread interest from numerous researchers in recent years (e.g. Pain & Harwood, 2004: *Journal of Sports Sciences*, 22, 813–826), although there remains paucity of research focussing on coaches perceptions and the reasons for these perceptions. The present study employed qualitative methods in order to increase understanding of coaches' perceptions of sport psychology and the factors that influence these perceptions.

Following ethics approval, 6 elite-level male coaches aged between 30–72 years (age mean 47 years), ranging in coaching experience from 2–50 years (coaching experience mean 21 years), and with experience of coaching in professional international soccer ($n = 1$), elite level handball ($n = 1$), elite level tennis ($n = 1$), elite level disability basketball ($n = 1$), and elite level boxing ($n = 2$) were interviewed using a semi-structured interview, and answered questions relating to, for example, their perception of sport psychology, their use of sport psychology, and the

links between sport psychology, confidence and performance. Thematic analysis of the transcribed interviews resulted in a number of themes emerging from the data, of which seven were identified as the most prominent. These seven were the use of sport psychology, experiences of working with a sport psychologist, perceived knowledge of sport psychology, factors which influence performance, personality, differences in perceptions of sport psychology, and funding.

Analysis and detailed exploration of these themes indicated support for Figone's (1999: *Scholastic Coach and Athletic Director*, 68, 4–5) suggestion that those coaches that fail to give due care and attention to applied sport psychology may do so because they are unaware of its intended meaning, and determined that the evolution of coaches attitudes is only possible with increased education. Further, this research highlighted the need for increased awareness of the need for sport psychology, and the benefits that this has to offer, and uncovered issues relating to the evolution of sport psychology.

HPSO1-04

Stair climbing in the workplace: Cost and effectiveness of two interventions

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Stair climbing is an ideal activity to promote in the workplace due to its ease and availability. Furthermore, stair climbing in this setting has been associated with health benefits such as improved cardiovascular fitness (Kennedy *et al.*, 2007: *Journal of Sports Science and Medicine*, 6, 448–454). In the past, several different methods have successfully encouraged workers to choose the stairs instead of the lift (Eves & Webb, 2006: *Preventive Medicine*, 43, 4–7). While it has been suggested these interventions are inexpensive, no study has compared the cost of different interventions. The current study compared a stall at an occupational health information day (Workplace Wellbeing Day) with point-of-choice prompts for (a) stair climbing response and (b) cost-effectiveness in four university buildings.

After one week of baseline observations, the Workplace Wellbeing Day took place. A subsequent week of observations assessed the effectiveness of the stall. Following this, the effects of posters positioned at the point-of-choice between the stairs and the lift were assessed for a further week. Logistic regression ($n = 4,279$; 49.5% women) showed no significant difference between baseline (47.9% stair climbing) and the Workplace Wellbeing Day (48.8% stair

climbing; $P = 0.83$). Point-of-choice prompts, however, increased stair climbing (52.6%; odds ratio = 1.20, confidence intervals = 1.06–1.37, $P < 0.01$).

The Workplace Wellbeing Day's inability to increase stair climbing may reflect the low number of employees attending, i.e. 3.6% of the invited employees. In contrast, the point-of-choice prompts were visible to employees entering the four buildings. The point-of-choice prompt intervention was also less expensive; the Workplace Wellbeing Day cost £550.24 in total compared to £22.32 for the point-of-choice prompts. Consequently, a Workplace Wellbeing Day is not only more expensive than a point-of-choice prompt, but is also inferior in promoting stair climbing due to its inability to disseminate the stair climbing message to all employees. In contrast, point-of-choice prompts were potentially visible to all employees using the four buildings and hence better able to disseminate the stair climbing message to the target audience.

HPHO2-01

Salivary immunoglobulin A and respiratory illness in elite male and female swimmers during a 6-month period of training and competition

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Heavy training and competition appear to be associated with a reduction in salivary immunoglobulin A (s-IgA). However, it has not been convincingly established whether this affects the incidence of respiratory illness. Furthermore, lower levels of s-IgA concentration have been reported at rest in female swimmers compared with male swimmers, but the effect of a period of training and competition on this response is yet to be determined (Gleeson *et al.*, 2004: *Exercise Immunology Review*, 10, 107–128). Therefore, the purpose of the present study was to examine the impact of a 6-month period of training and competition on mucosal immunity and respiratory illness in a cohort of elite male ($n = 7$) and female ($n = 5$) swimmers. Following local ethical approval, unstimulated, timed saliva samples were collected at rest on 8 occasions over a 6-month period leading up to, during and after an international swimming competition for the analysis of s-IgA and salivary osmolality. In addition, symptoms of respiratory illness were recorded weekly. Salivary data were analysed using a one factor repeated measures ANOVA and *Post hoc t* tests with Holm-Bonferroni correction were applied where

appropriate. Significance was set at $P < 0.05$. There were no significant changes in saliva flow rate, s-IgA concentration or the ratio of s-IgA to osmolality ($P > 0.05$) throughout the training study period. There was a significant main effect of time for s-IgA secretion rate ($P = 0.018$), which was significantly lower at week 22 (pre-competition) compared with week 26 (post-competition; $P < 0.05$). Lower levels of s-IgA secretion rate were also observed at week 7 (pre-trials) and week 17 (post-intensified training) compared with week 26, although these did not quite reach significance ($P = 0.054$). Significant differences in gender were found in all the salivary measures with females exhibiting lower levels than males ($P > 0.05$). However, the responses of these measures to the training period did not differ between genders. Episodes of respiratory illness were highest during week 8 of the study (post-trials) where seven swimmers (three male and four female) reported ill. However, this did not appear to be directly related to lower s-IgA levels within this cohort. These results suggest that a 6-month season of swim training and competition may result in significant changes in the s-IgA secretion rate but not the s-IgA concentration. Significant differences in gender exist in resting salivary composition but these are not differently affected by swim training and competition.

HPO2-02

No effect of one month of moderate aerobic exercise on bacterially-stimulated neutrophil degranulation responses in chronic kidney disease patients

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Patients with chronic kidney disease (CKD) suffer from immune dysfunction leading to a high incidence of infections, a major cause of morbidity and mortality among these patients. Neutrophils are central to innate host defence and it was recently demonstrated that their ability to respond to a bacterial challenge *in vitro* is improved in CKD patients after an acute bout of moderate exercise (Viana *et al.*, 2008: 13th ECSS Congress, in press). However, the effect of regular physical activity remains to be determined. Therefore, the aim of this study was to investigate the effects of 1 month of regular moderate aerobic exercise on bacterially-stimulated neutrophil degranulation responses in CKD patients.

Table I. Circulating neutrophil count, plasma elastase concentration and bacterially-stimulated neutrophil degranulation responses to the exercise programme (mean \pm $S_{\bar{x}}$).

	Baseline	1 month
Neutrophils ($\times 10^9 \cdot L^{-1}$)	4.0 ± 0.5	4.2 ± 0.5
Plasma elastase ($\mu g \cdot L^{-1}$)	88 ± 10	81 ± 9
Bacterially-stimulated elastase release per neutrophil ($fg \cdot cell^{-1}$)	551 ± 43	546 ± 67

With local NHS ethical board approval 12 patients (eight males) with a mean age of 59 years (range 50–69 years), with Stage 4 CKD, exercised for 30 min at least 5 times per week for a total period of 1 month. The exercise programme consisted of brisk walking at a speed that was adjusted to correlate to a Borg Rate of Perceived Exertion (RPE) of 12–14, and a heart rate range that was elicited by the target RPE. Patients kept exercise diaries and were monitored to ensure compliance. Patients performed a standard 30 min exercise test on a motorised treadmill before (baseline) and after 1 month of regular exercise and resting venous blood samples were collected on both occasions. Elastase release from unstimulated (plasma elastase) and bacterially-stimulated neutrophils was determined by ELISA. Results were analysed using Student's paired *t* tests.

Average RPE response to the exercise test at 1 month (mean 11, $S_{\bar{x}} = 0$) was lower than at baseline (mean 13, $S_{\bar{x}} = 0$, $P = 0.003$). However, resting circulating neutrophil count ($P = 0.723$), plasma elastase concentration ($P = 0.535$) and bacterially-stimulated elastase release per neutrophil ($P = 0.944$) did not change over this time (Table I). Plasma volume did not change in response to training ($P = 0.433$).

These results suggest that 1 month of moderate aerobic exercise in CKD patients has no effect on the ability of neutrophils to respond to a bacterial challenge *in vitro*.

HPHO2-03

Psychophysiological mediators of physical fatigue in breast cancer patients receiving adjuvant chemotherapy

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Cancer and its treatment are associated with physical fatigue, which we operationally defined as increased perception of effort during physical tasks. The purpose of this study was to determine whether the hypothesised increase in rating of perceived exertion

(RPE) in cancer patients receiving chemotherapy is associated with abnormal cardiorespiratory and metabolic responses to exercise, muscle weakness, and altered affect.

Following ethical approval, 10 female breast cancer patients receiving chemotherapy (age mean 47.5, $s = 10.2$ years) were age-matched to 10 female healthy controls, and visited the laboratory on two occasions. On each occasion, positive and negative affect, resting blood lactate, hand-grip strength, and haemoglobin levels were measured. Participants cycled for 2 min each at 0, 25, 50 and 75 W. During the incremental test, RPE (15-point Borg scale) was quantified at the end of each stage, whilst cardiorespiratory and metabolic parameters were measured continuously. Blood lactate was also measured 1 min post exercise. In patients, Visit 1 occurred 1–2 days before chemotherapy, whilst Visit 2 occurred 3–5 days post chemotherapy. The same time period between visits (4–7 days) was observed for controls. All RPE and physiological data were analysed using mixed model (group \times time \times power output) ANOVAs. Blood lactate production (BLacP), haemoglobin, hand-grip strength and affect were analysed using mixed model (group \times time) ANOVAs.

Patients reported significantly higher perceived exertion than controls (main effect of group; $P = 0.01$). Patients also tended to report higher RPE after chemotherapy (group \times time interaction; $P = 0.067$) despite no alterations in affect and any physiological variables. The only physiological variables that were significantly different between the two groups included haemoglobin (lower in patients; $P < 0.002$), BLacP (higher in patients; $P = 0.038$), mean arterial blood pressure (lower in patients; $P < 0.008$) and respiratory exchange ratio (higher in patients; $P = 0.009$).

The chronic effect of breast cancer and its treatment on physical fatigue may be mediated, in part, by anaemia and its effects on metabolic responses to exercise. Interestingly, the lower haemoglobin levels were not associated with the normal

compensatory increases in cardiac output with consequent lower blood pressure. None of the measured psychological and physiological variables can explain the acute effect of chemotherapy on perceived exertion. Therefore, this effect might be mediated by central nervous system changes which were not measured in this study.

HPHO2-05

The effect of acute hypoxia on peak oxygen consumption during upper compared to lower body exercise

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At sea level upper body exercise elicits approximately 70% $\dot{V}O_{2\text{peak}}$ of that attained during lower body exercise (Sawka *et al.*, 1983: *Journal of Applied Physiology*, 54, 113–117). Although it is well established that exposure to altitude results in reduced $\dot{V}O_{2\text{peak}}$ these data are almost exclusively from lower body exercise studies. Therefore we examined the effect of reduced $F_{I}O_2$ and the magnitude of reduction in $\dot{V}O_{2\text{peak}}$ in upper compared to lower body exercise.

With local ethical committee approval nine healthy male participants (age mean 22, $s = 2$ years) undertook three upper and three lower body discontinuous (30 sec intervals) incremental exercise (UBX; LBX) tests to volitional exhaustion whilst breathing either normoxia (N) or normobaric hypoxia (H_1 and H_2); $F_{I}O_2s \approx 0.21, 0.15$ and 0.13 respectively. Exercise commenced with a resistance of 70 W for cycle ergometry and 35 W arm cranking and was increased by 30 and 15 W respectively every 3 min thereafter; cadence was maintained at 70 rpm throughout. Heart rate (HR) and arterial haemoglobin oxygen saturation (SpO_2) were monitored continually. Data were examined using general linear model analysis of variance.

Table I. Physiological variables at peak exercise (mean \pm s).

	LBX			UBX		
	N	H_1	H_2	N	H_1	H_2
Peak Power output (W) ^{#,†}	273 \pm 49	250 \pm 37	223 \pm 28	135 \pm 27	127 \pm 20	123 \pm 18
$\dot{V}O_{2\text{peak}}$ (L \cdot min ⁻¹) ^{#,†,Φ}	3.52 \pm 0.50	3.04 \pm 0.46	2.68 \pm 0.27	2.53 \pm 0.35	2.15 \pm 0.40	2.04 \pm 0.34
HR (b \cdot min ⁻¹) ^{#,δ}	189 \pm 12	188 \pm 12	183 \pm 13	180 \pm 13	180 \pm 13	176 \pm 14
SpO_2 (%) ^{#,†,Φ}	96 \pm 2	83 \pm 4	73 \pm 4	96 \pm 2	85 \pm 5	79 \pm 4

Notes: [#] $P < 0.001$ exercise mode.

[†] $P < 0.001$.

^δ $P < 0.01$ $F_{I}O_2$.

^Φ $P < 0.05$ exercise mode \times $F_{I}O_2$ effect size $\eta^2 = 0.03$ – 0.80 .

Physiological responses are given in Table I. $\dot{V}O_{2\text{peak}}$ was 71 ± 10 and $76 \pm 8\%$ of that in LBX at H_1 and H_2 respectively. Peak blood lactate was $> 10 \text{ mmol} \cdot \text{L}^{-1}$ in UBX and LBX and did not vary with $\dot{V}O_2$.

To conclude, the reduction in $\dot{V}O_{2\text{peak}}$ appears to be less in UBX compared to LBX at the lowest $\dot{V}O_2$. This is potentially relevant to athletes conducting UBX at altitude.

HPH02-06

Cycling cadence affects physiological responses at maximal lactate steady state

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Background. Maximal lactate steady state (MLSS) is the highest power output above which there is a continual rise in blood lactate concentration ($[\text{lac}^-]_B$) and is a useful descriptor of endurance training status. Cadence influences physiological responses to exercise, but how it affects physiological parameters reflective of MLSS remains unknown.

Purpose. To investigate the effects of pedal cadence on physiological parameters whilst cycling at MLSS.

Methods. Following ethical approval 11 healthy males were recruited. MLSS was defined as the power output at which $[\text{lac}^-]_B$ increased no more than $0.5 \text{ mmol} \cdot \text{L}^{-1}$ between min 15 to 30. All subsequent exercise was performed at MLSS. Participants cycled at their preferred cadence (mean \pm s; $87 \pm 7 \text{ rpm}$) from min 0 to 15. From min 15 to 30 cadence was maintained (control), increased (+15 rpm; $102 \pm 7 \text{ rpm}$) or decreased (−15 rpm; $72 \pm 7 \text{ rpm}$). $[\text{lac}^-]_B$, acid-base balance, HR and RPE were measured every 2 min. Respiratory variables were measured breath-by-breath.

Results. All differences are expressed relative to control. Responses were similar during the first 15 min of each trial. RPE was increased in +15 rpm ($P < 0.05$) although was unchanged in −15 rpm. \dot{V}_E (control: $72.2 \pm 12.0 \text{ L} \cdot \text{min}^{-1}$) increased to $91.8 \pm 18.7 \text{ L} \cdot \text{min}^{-1}$ in +15 rpm ($P < 0.01$) and decreased to $70.8 \pm 13.7 \text{ L} \cdot \text{min}^{-1}$ in −15 rpm ($P < 0.01$). $\dot{V}O_2$ increased from $2.88 \pm 0.37 \text{ L} \cdot \text{min}^{-1}$ in control to $3.03 \pm 0.53 \text{ L} \cdot \text{min}^{-1}$ in +15 rpm ($P > 0.05$) and decreased to $2.66 \pm 0.43 \text{ L} \cdot \text{min}^{-1}$ in −15 rpm ($P < 0.01$). The change in HR in +15 rpm (160 ± 12) and −15 rpm (153 ± 12) exceeded that of the control (155 ± 9 ; $P < 0.05$) Acid-base disturbance was greater in +15

rpm and attenuated in −15 rpm, these changes exceeded the control ($P < 0.05$). $[\text{lac}^-]_B$ (control: $3.94 \pm 1.94 \text{ mmol} \cdot \text{L}^{-1}$) was higher in +15 rpm ($4.71 \pm 1.86 \text{ mmol} \cdot \text{L}^{-1}$; $P < 0.05$) and lower in −15 rpm ($3.19 \pm 1.73 \text{ mmol} \cdot \text{L}^{-1}$; $P < 0.05$).

Discussion. An increase in pedal cadence increased metabolic rate and caused changes in other physiological responses perhaps by reducing the efficiency of type I muscle fibres and promoting type II fibre recruitment. In contrast, decreasing cadence reduced several markers of physiological stress possibly by positioning type I muscles fibres on the more efficient portion of their efficiency-velocity relationship and reducing type II fibre recruitment.

Conclusion. Pedal cadence influences physiological responses to cycling exercise at MLSS. We highlight the importance of controlling pedal cadence when determining and cycling at MLSS.

HPH02-07

Ibuprofen ameliorates delayed onset muscle soreness and suppresses the repeat bout effect

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Delayed onset muscle soreness (DOMS) is a familiar consequence of participating in unaccustomed exercise, particularly if it involves eccentric muscle contractions. The aetiology of DOMS is thought to involve an inflammatory reaction to muscle damage but the administration of anti-inflammatory drugs does not always reduce DOMS. One consequence of DOMS is that a subsequent exposure to similar damaging exercise is followed by much reduced muscle soreness; a phenomenon known as the repeated bout effect. The aim of this study was to establish if post-exercise administration of the anti-inflammatory drug (NSAID) Ibuprofen would affect DOMS and the subsequent expression of the repeated bout effect.

With institutional ethical approval, thirteen female participants aged 19–22 years (mean 20.2, $s = 0.9$) with no history of resistance training or adverse reaction to NSAIDs, performed 4 sets of eccentric contractions of the elbow flexors, using their non-dominant arm, at a resistance of 110% of their concentric 1-rep max. After 14–18 days they repeated the exercise to evaluate the repeated bout effect. Following a further period of at least 6 weeks rest, to attenuate any subsequent repeated bout effect, a

further two bouts of eccentric elbow flexions was undertaken with 14–18 days between bouts. Immediately following the first bout of exercise participants took 1200 mg of ibuprofen per day (3×400 mg) for three days, or a similar dose of glucose placebo, in a single blind, randomised, cross-over design. The opposite treatment was administered after the first bout of exercise following the six week washout period. Outcome measures were recorded at 24 h intervals after each exercise bout for 3 days. Peak muscle soreness, evaluated on a 7 point Talag scale, was significantly diminished after the repeated bout when the placebo was taken after the first bout ($t=4.629$, $P < 0.001$) but significantly increased when ibuprofen had been administered ($t=2.941$; $P < 0.05$). Peak soreness was similar for the ibuprofen treatment after the repeated bout to that for the placebo treatment after the first bout ($t=1.806$; $P > 0.05$).

These data suggest that taking ibuprofen after muscle-damaging exercise can reduce soreness, but that it interferes with the repeated bout effect, presumably by inhibiting the inflammatory response.

HPHO2-08

Effects of arm-crank training on walking performance and lower-limb circulation in claudicants

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Peripheral arterial disease of the lower-limbs is often accompanied by intermittent claudication that is characterised by ischaemic leg pain during walking, which is relieved by rest. Regular supervised exercise can improve this symptom (Gardner & Poehlman, 1995: *Journal of the American Medical Association*, 274, 975–980), but since lower-limb exercise can be painful, the desire and ability of these patients to perform lower-limb exercise might be limited. Arm-cranking is a useful alternative training method for claudicants because it is well tolerated and can improve walking performance to a similar extent as cycle-ergometry training (Zwierska *et al.*, 2005: *Journal of Vascular Surgery*, 42, 1122–1130). However, mechanisms of improved walking performance following arm training in claudicants are poorly understood. The purpose of this study was to investigate changes in walking performance and lower-limb circulation following arm training in claudicants.

With Local Research Ethics Committee approval, 44 claudicants (mean age 70, $s=8$ years) were randomly allocated either to an arm training or

non-exercise control group. The arm training group completed twice weekly supervised exercise sessions for 12 weeks at 60–70% peak intensity of exercise achieved on an incremental arm-crank assessment. Lower-limb circulatory function was assessed at baseline and 12 weeks using venous occlusion plethysmography (post-occlusive reactive hyperaemia), and near-infrared spectroscopy (probe placed on most symptomatic calf during walking exercise). Pain-free and maximum walking distances were assessed at baseline and 12 weeks using an incremental treadmill protocol (Labs *et al.*, 1999: *Circulation*, 100, 75–81). Following appropriate checks on underlying assumptions, mixed-model (group by time) analyses of covariance (ANCOVA) were used to detect changes in outcome measures between groups, with statistical significance set at $P \leq 0.05$.

There were interactions, with increases in the arm training group for pain-free walking distance (mean 81, $s=132$ m, $P=0.034$), maximum walking distance (mean 155, $s=145$ m, $P=0.014$), lower-limb post-occlusive blood flow (mean 29, $s=95$ mL \cdot 100 mL⁻¹ \cdot min⁻¹ \cdot s, $P=0.045$), the time constant for deoxygenated haemoglobin during walking (mean 5.5, $s=10.3$ s, $P=0.044$), and oxygen pulse measured at rest (mean 0.3, $s=0.7$ mL \cdot beat⁻¹, $P=0.036$) and during sub-maximal exercise (mean 0.5, $s=1.4$ mL \cdot beat⁻¹, $P=0.025$), with little or no equivalent changes in the control group.

The results suggest that the improvement in walking performance following arm training in claudicants is accompanied by favourable adaptations in lower-limb circulation and increased stroke volume. These adaptations could, in part, explain the improvements in walking performance following arm training in claudicants.

HBIO1-01

A comparison of three-dimensional breast displacement and breast comfort during overground and treadmill running

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It is not known whether breast support requirements differ between overground and treadmill running. All previous studies have presented breast displacement and breast comfort data during treadmill running, with the assumption that results are applicable to overground sporting activities. Therefore, the purpose of this study was to investigate three-dimensional breast displacement and breast comfort in four breast support conditions during overground and treadmill running.

Following ethical approval, six female participants with D cup breasts (age 24.8 ± 7.3 years, height 1.66 ± 0.04 m, body mass 65.7 ± 6.8 kg, band size 34 ± 1.8 (mean \pm s)) had retro-reflective markers placed on the left and right nipples, anterior superior iliac spines (ASIS) and clavicles. Five calibrated ProReflex infrared cameras (100Hz, Qualisys, Sweden) measured 3D displacement of the markers. In four randomised breast support conditions (no bra, everyday bra and 2 sports bras) participants completed five overground running trials ($3 \text{ m} \cdot \text{s}^{-1} \pm 0.1 \text{ m} \cdot \text{s}^{-1}$) over a 10m indoor runway and for the treadmill condition speed was steadily increased to $3 \text{ m} \cdot \text{s}^{-1}$ and 5 gait cycles were recorded. Subjective feedback on breast comfort was collected quantitatively using a visual analogue scale after each breast support condition (Mason, Page and Fallon, 1999: *Australian Journal of Science and Medicine in Sport*, 2, 134–144).

Breast displacement data for both running surfaces were comparable with previous breast motion studies and significantly differed ($P < 0.05$) between breast support conditions. A two-way repeated-measures ANOVA revealed no significant effect of running surface on resultant ($P = 0.12$), vertical ($P = 0.12$), mediolateral ($P = 0.42$) or anteroposterior ($P = 0.09$) breast displacement. Spearman's rank correlation coefficient established the relationship between breast comfort and displacement for both running surface conditions. Significant moderate correlations ($r = 0.45$ – 0.68 , $P < 0.05$) were found between breast comfort and displacement for both surface conditions. The compression sports bra was rated as the most comfortable breast support condition by participants.

Findings suggest that three-dimensional breast displacement did not differ significantly between overground and treadmill running; therefore earlier breast motion studies that examined treadmill running are applicable to overground running. The importance of wearing a sports bra during exercise was confirmed. Future research should assess in more detail how breast movement is affected by gait kinematics.

HBIO1-02

Three dimensional kinematics of the breast during a two step star jump

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Research has established a relationship between three-dimensional (3D) breast motion displacement

and breast pain during running. Anecdotal evidence suggests that jumping also causes breast pain. Verscheure *et al.* (2000: *Medicine and Science in Sports and Exercise*, 32, S1299) investigated breast support during jumping but bare-breast analysis was omitted. This type of data may inform sport brassiere design and aid our understanding of breast pain. Therefore, the aim was to quantify and investigate bare-breast kinematics and comfort during jumping in a bare breast condition across breast cup sizes.

Following institutional ethical approval, 39 females with breast cup sizes A to JJ gave written informed consent to participate in this study. Markers were positioned on left and right clavicles and anterior superior iliac spines to determine body movement, which was then eliminated from the movement of a right nipple marker. Following a demonstration, 3D marker coordinates were recorded during five consecutive two-step star jumps using ProReflex Infrared cameras (Qualisys, Sweden, 100 Hz), after which participants rated their breast comfort. Peak resultant, vertical, mediolateral (m/l), anteroposterior (a/p) displacement^(cm), velocity^(cm·s⁻¹) and acceleration^(G) of the breast were averaged from the 2nd, 3rd and 4th jump. One-way ANOVAs compared breast kinematics during jumping and Pearson's correlations assessed the relationship of breast comfort and cup size to breast kinematics.

The maximum resultant breast displacement, velocity and acceleration values recorded during jumping were 18.66 cm, $93.07 \text{ cm} \cdot \text{s}^{-1}$ and 3.63 G for JJ cup. In D cups mean peak bare-breasted vertical displacement during jumping was 7.84 cm, compared to 7.98 cm reported during running (Lorentzen and Lawson, 1987: *The Physician and Sportsmedicine*, 15, 128–139). This level of displacement has previously been associated with breast discomfort. As expected significantly more vertical displacement ($F = 58.147$, ₍₂₎ $P = 0.000$) and vertical velocity ($F = 25.344$, ₍₂₎ $P = 0.000$) occurred during jumping compared to m/l and a/p, however there was no difference in multiplanar acceleration ($F = 2.202$, ₍₂₎ $P = 0.115$). Resultant ($r = 0.88$, ₍₁₁₄₎ $P < 0.05$) and vertical ($r = 0.89$, ₍₁₁₄₎ $P < 0.05$) displacement increased as breast cup size increased. Breast comfort decreased as breast cup size increased ($r = 0.58$, ₍₁₁₄₎ $P < 0.05$).

In conclusion, a two-step star jump produced similar vertical displacement and velocity to that previously reported during running. The predominance of the vertical kinematics components during the two-step star jump may partially explain the discomfort felt and highlights the importance of reducing this in sports bra design.

HBIO1-04

Does contract-relax treatment method affect on hip range of motion in patients with muscle imbalance

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Back pain as a widespread epidemic could be a consequence of various stresses on the spinal column caused by muscular imbalance (MI) and structural deformities, due to factors such as lifestyle, level of activity, obesity. These factors can cause anatomical deformities in the pelvis, spinal column, and lower extremities, and muscular imbalance between hip and lumbar flexors and of the hip and back. The evidence shows that the interval stretching against resistance using Contract-Relax (CR) method on shortened hamstrings can regain muscular balance between the hip flexor and extensor muscles resulting in a reduction in back pain. The purpose of this study was to investigate the effect of PNF-CR therapy on patients with chronic uni-lateral back pain and shortened hamstring muscles.

Fifty-six female patients with one year history of low back pain were chosen. The patients were randomly categorized into an experimental (age mean 34, $s=5$ years, height mean 161, $s=4$ cm, weight mean 69, $s=12$ kg) and a control group (age mean 33, $s=5$ years, height mean 161, $s=9$ cm and weight mean 67, $s=8$). Each subject received a total of twelve sessions of PNF-CR, three times per week with each session lasting 90 min. The Universal Goniometer (UG) was used to measure hip range of motion in terms of hamstring limitation and clinical Goniometer (CG) was used the lumbar total flexion. The Student t test and R^2 with were used to analyse the data.

The results of this study showed that there is a significant difference in increments of hip range of motion ($P < 0.01$) between the experimental and control group. These results showed a high correlation between the hip angle range of motion against the number of sessions for the experimental group ($r^2=87\%$). A positive correlation was also found between improvement in back flexion angle and the number of treatment sessions (before and after treatment ($P < 0.01$, $R^2=91\%$). Also according to the numerical pain scale a significant difference in LBP reduction was found in experimental group ($P < 0.01$). Therefore, it is concluded that PNF-CR could be used as an effective method to reduce back pain and increase hip and back range of motion.

HBIO1-05

Inertial sensing of centre of mass using quaternions

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Gait analysis is usually laboratory based, relatively expensive regarding time and expenses. Inertial sensing may provide an alternative solution. A problem with inertial sensing is that measurements are in the object system. Combining accelerometers, gyroscopes and magnetometers into an Inertial Measurement Unit (IMU) creates the possibility to transform accelerations from the object to an orthogonal system using a rotation matrix. Quaternions provide a stable option to transpose vectors from the object system onto the orthogonal system. The aim of this study is to test the concurrent validity of IMU (*Xsens, Enschede, Netherlands*) and optical motion capture system (*Qualisys, Stockholm, Sweden*) derived accelerations in the orthogonal z axis of a point estimate for Centre of mass (CoM) during walking.

Four men and one woman (Age; mean 23.4, $s=3.8$, Weight; mean 80.5, $s=14.3$ kg and height; 1.8, $s=5.4$ m) volunteered for the study. The IMU was fixed with adhesive tape over the fourth lumbar vertebra. Each subject walked three times at a self-selected walking speed through the calibrated measurement volume. Acceleration of the IMU was measured and transposed onto the orthogonal system. Displacement of a reflective marker attached to the IMU was measured by the optical motion capture system. Both systems measured with the same sample frequency (100 Hz). The signal was differentiated to calculate acceleration in the orthogonal system. Both datasets were smoothed with a running average of ten points. z axis amplitudes were extracted and compared using t test, Inter Class Correlation Test (ICC) and random error statistical analysis.

z axis amplitudes from the IMU (mean 2.1, $s=1.2$ ms⁻²) and the optical motion capture system (mean 2.3, $s=1.2$ ms⁻²) were not significantly different ($P \geq 0.05$). In addition ICC=0.952 and random error 0.571 ms⁻² demonstrate strong agreement between systems.

Optical motion capture systems are seen as the "golden standard" due to the high level of accuracy and reliability. IMU accelerations transposed into the orthogonal system showed concurrent validity with this system. The results indicate that Quaternions based IMUs have the potential to be an

alternative to optical motion capture systems. However further methodological issues have to be solved.

Quaternions provide an accurate solution to transpose accelerations on the orthogonal system.

HBIO1-06

A comparison of Pilates and Williams exercises on chronic low back pain

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Specific exercise therapy approaches are gaining growing support in treating low back pain disorders. Therapeutic approaches developed from the Pilates method are becoming increasingly popular. The William's method is a widely accepted and effective method for treating low back pain, little scientific evidence exists about effects of the modified Pilates exercise for non specific low back pain. The purpose of this study was to investigate the efficacy of a specific therapeutic exercise approach based on Pilate's exercise and William's exercises in active individuals with non specific low back pain.

With institutional ethics approval 44 nurses (38 female and 6 male) with the mean age of 37.3, $s=6.8$ years; mean height of 163.6, $s=8.8$ cm and mean weight of 65.1 $s=10.9$ Kg who had at least 3 months of non specific low back pain history were randomly selected and entered into control ($n=16$), Williams ($n=16$) and Pilates ($n=16$) groups. In this study we used a single blind randomised controlled trial. The two experimental groups undertook six week programme of mat-based modified Pilates and Williams exercises. An assessor blind to group allocation conducted assessments of pre and post intervention. The quality and perceived intensity of pain were assessed using the McGill Pain Questionnaire (MPQ), visual analogue scales (VAS) and pressure biofeedback to assess stability of lumbopelvic and tape measure for leg length discrepancy.

Demographic and baseline clinical characteristics were similar for groups. A significant reduction in pain intensity (Pilates $P=0.000$, Williams $P=0.001$) and Improved stability (Pilates $P=0.000$, Williams $P=0.002$) and leg length discrepancy (Pilates $P=0.001$, Williams $P=0.003$) was seen in the training groups. The control group showed no significant differences in the same measures. Although significant improvements were observed in both groups, the Pilates group showed significantly larger improvements than the Williams group on all outcome variables throughout the entire

experimental period. The Pilates method group showed better compliance and subjective response to treatment. However, the differences between the two groups statistically were not significant.

From this study we concluded that the Pilates method was comparable to those achieved with the Williams method, suggesting its use as an alternative approach to the treatment of non specific low back pain.

HBIO1-07

The effect of treadmill running duration on plasma acylated ghrelin concentrations

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High intensity (70% of $\dot{V}O_{2max}$) running suppresses plasma acylated ghrelin – a hormone known to stimulate hunger (Broom *et al.*, 2007: *Journal of Applied Physiology*, 102, 2165–2171). This has implications for the role of exercise in weight control, but further information is required to characterise the ghrelin response to exercise. This study examined the effect of exercise duration on plasma acylated ghrelin concentrations. Following ethical approval, nine healthy Caucasian males (age, mean 23.2 $s=2.1$ y, BMI 22.8 $s=1.5$ $kg \cdot m^{-2}$, $\dot{V}O_{2max}$ 63.4 $s=5.8$ $mL \cdot kg^{-1} \cdot min^{-1}$) undertook three main trials: short duration run (45 min, 70% of $\dot{V}O_{2max}$), long duration run (90 min, 70% of $\dot{V}O_{2max}$) and control, in a random order at least seven days apart. Diet and exercise were standardised 24 h prior to each of the nine-hour trials which began in the morning after an overnight fast. Treadmill runs were undertaken as the first 45 and 90 min of the short and long duration trials respectively. Hunger was measured using a “ratings of perceived hunger” scale ranging from 0 “Not Hungry” to 15 “Very Hungry”. Blood samples were collected periodically from a venous cannula for the determination of plasma acylated ghrelin via enzyme immunoassay (SPIO Bio, France).

Two-factor ANOVA revealed a main effect of trial ($P=0.001$) for plasma acylated ghrelin, while time ($P=0.063$) and interaction ($P=0.097$) effects approached significance. For the effect of trial, Bonferroni post hoc tests indicated that control trial values differed significantly from values on the short duration ($P=0.041$) and the long duration ($P=0.005$) run trials. Figure 1 demonstrates that acylated ghrelin was suppressed during both exercise

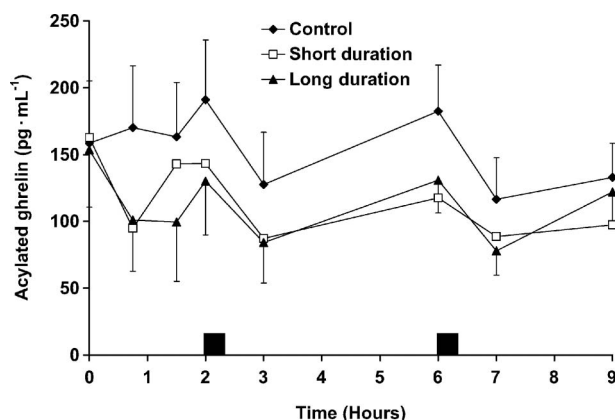


Figure 1. Plasma acylated ghrelin concentrations (mean \pm SEM, $n = 9$) during the three trials. Black rectangles indicate test meals.

trials with a longer lasting suppression on the long duration trial. Ratings of perceived hunger (data not shown) were also suppressed on the exercise trials (main effect of trial $P = 0.039$, time $P < 0.0005$ and trial \times time interaction $P < 0.0005$) and this suppression coincided with the suppression of acylated ghrelin. These findings demonstrate that the duration of suppression of hunger and plasma acylated ghrelin during high intensity treadmill running is proportional to the duration of exercise.

HPHO3-01

Muscle performance decrease after eccentric exercise—possible explanations from muscle oxygenation and EMG activity

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Changes in muscle oxygenation are known to affect human performance (Hepple, 2002: *Canadian Journal of Applied Physiology*, 27, 56–69). However, the unique role of oxygen in muscle performance decreases, whereby oxygenation levels are only altered by changes in muscle actions has not been investigated. Therefore, the purpose of this study was to determine whether differences in tissue oxygenation index (TOI) between concentric (CON) and eccentric (ECC) exercises provide a better understanding of muscle performance decreases. An additional purpose was to assess for muscle activity changes before, during and after each exercise.

With institutional approval, on two separate days, ten moderately trained athletes (nine males, age

mean 27.4, $s = 3.6$ years and one female, age 26) were instructed to perform maximal isokinetic knee extension exercises under concentric (MKE_{CON}) and eccentric (MKE_{ECC}) conditions at 60° s^{-1} until exhaustion. Isometric maximal voluntary contractions (IMVC) were performed prior and after MKE exercises. Torque, joint position and velocity were recorded and displayed simultaneously by an isokinetic dynamometer (Biodex System 3, Shirley, New York, USA). Electromyographic (EMG) muscle activity was recorded from the vastus lateralis (VL). Muscle oxygenation was acquired from the VL with a NIRS device (NIRO 300, Hamamatsu Photonics, Japan).

TOI significantly decreased during both exercises ($P < 0.05$), but the decrease observed between baseline and end-exercise values was significantly greater during MKE_{ECC} than during MKE_{CON} ($P < 0.05$). After an initial drop, TOI increased from 20 to 100% of exercise duration during MKE_{CON} to reach a similar end-exercise value as at the beginning of the exercise ($\sim 55\%$). During MKE_{ECC}, TOI significantly decreased from 10 to 100% of exercise duration ($P < 0.05$). MKE_{ECC} resulted in a significant increase in end-exercise integrated EMG (iEMG) ($P < 0.05$). Compared to CON, post-ECC exercise IMVC resulted in a significantly greater torque decrement ($P < 0.05$) accompanied by a significant decrease in iEMG ($P < 0.05$).

Even though eliciting higher metabolic demand (Perrey *et al.*, 2003: *Journal of Applied Physiology*, 91, 2135–2142) MKE_{CON} did not induce a greater end-exercise muscle oxygenation decrease than MKE_{ECC}. During MKE_{ECC}, a higher intramuscular pressure, increasing blood vessels compression, may have been the cause of this phenomenon. As suggested by end-exercise iEMG increase, it seems that an increase in neural drive occurred to prevent from performance decrease. Furthermore, the observed iEMG decrease during post-ECC exercise IMVC suggests a selective damage of fast twitch fibres.

HPHO3-02

Let's get moving: A feasibility trial of a "physical activity care pathway" in primary care settings

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The health benefits of physical activity are well documented and yet the evidence base on effective

population level interventions aimed at increasing activity levels in the UK adult population is sparse. Primary care practitioners are well placed to identify adults who do not meet the current physical activity recommendations and to help support patients initiate and maintain behaviour change. The purpose of this study was to evaluate the feasibility of the new physical activity care pathway (PACP) developed by the Department of Health (DH) in 2007.

The PACP pilot evaluation was conducted with a convenient sample of 15 practices from across 11 London PCTs, commencing in two waves during 2007/08. Patients were recruited by the practice either “opportunistically” during routine consultations or targeted via disease registers. The PACP protocols involved screening patients using the Genral Practice Physical Activity Questionnaire (GPPAQ) and those identified as “insufficiently active” were invited to receive a brief intervention based on motivational interviewing (MI) methods. Patients enrolled in the PACP received a “Let’s Get Moving” Pack and were signposted to local opportunities for physical activity.

Both process and impact evaluation were conducted using the electronic data systems within the practices (EMIS) and focus group discussions with practitioners. Data entered into EMIS by the health professionals provided details on PACP implementation and focus group discussions explored feasibility and barriers to implementation. The PACP evaluation was classified as a service audit by the National Research Ethics Service.

Results from the first seven months of implementation show that 428 patients were recruited across the 15 practices. Follow-up consultations were completed with 61 patients in Wave One and are still underway for patients in Wave Two. Qualitative data from focus group discussions revealed overall a very favourable response towards implementation of the PACP. Practitioners reported that the PACP provided a valuable audit mechanism to help them review patient PA behaviour and to monitor patient outcomes. The use of MI methods was reported to “empower patients” and one practitioner stated that MI has “made me a better clinician”. Other findings were that the PACP helped practitioners audit and monitor patients’ physical activity, increased the number of patients approached regarding PA and promoted “person-centred” styles of consultation that facilitated patient choice and self-efficacy.

The final evaluation report is due in September 2008 and the results will inform further development of the PACP and assist the Department of Health with plans for wider dissemination.

HPHO3-03

“Exercise is not part of our culture” and other socio-cultural barriers to physical activity participation among black professional women in South Africa

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Associations between physical inactivity, adverse health and hypokinetic diseases have been widely researched. Recent studies have revealed that the South African population has moved extensively along the epidemiological transition towards a disease profile related to Western lifestyle, with more deaths from chronic diseases of lifestyle (Steyn, 2006: In *Chronic diseases of lifestyle in South Africa 1995–2005*, edited by K. Steyn *et al.*, Cape Town: Medical Research Council). Black women have been identified as a high risk group, with the highest levels of inactivity, overweight and obesity (Puoane *et al.*, 2002: *Obesity Research*, 10, 1038–1048).

This study used qualitative methods to investigate barriers to physical activity participation in two generations of black professional women (teachers, nurses, social workers and public managers). The two generations reflect pre- and post democracy age groups in South Africa. The older generation, aged 35 to 45 years, spent formative years in apartheid South Africa, disadvantaged by apartheid policy. The younger generation, aged 18–21 years, spent formative years in post-apartheid South Africa, post-1990, under a constitution which guarantees equality and non-discrimination.

With institutional ethics approval, 47 black professional women (20 from the older generation, mean age 39.9, $s=3.3$ years; and 27 from the younger generation, mean age 19.8, $s=0.9$ years) were interviewed using a semi-structured interview guide. Interviews were transcribed verbatim and data were managed and analysed according to steps described in Cresswell (2003: *Research design: qualitative, quantitative and mixed methods approaches*. London: Sage). Data verification was done according to Guba’s model of trustworthiness (Krefting, 1991: *The American Journal of Occupational Therapy*, 45(3):214–222). An independent coder verified the coding.

Three sub-themes were identified relating to barriers to physical activity participation: personal, environmental and socio-cultural factors. The socio-cultural factors, the focus of this paper, included the lack of social support, exercise “not being a part of

African culture”, traditional gender roles, dress code, exercise associated with the young, exercise associated with undesirable weight loss and negative comments by the community.

Findings have highlighted that the advent of democracy in South Africa has brought change into the lives of both generations and offers more career and lifestyle choices. However, these are influenced negatively by more conservative socio-cultural barriers.

HPHO3-04

The acute effects of brisk walking on appetite, energy intake and plasma acylated ghrelin concentration in healthy young males

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Brisk walking can confer a diverse range of health benefits yet conflicting findings exist regarding the ability of brisk walking to favourably influence weight control. An augmentation of appetite and energy intake may be implicit in this regard (Morris & Hardman, 1997: *Sports Medicine*, 23, 306–332). Further work is required to characterise the effect of brisk walking on appetite regulation, energy intake and energy homeostasis, therefore this study examined the effect of an acute bout of brisk walking on appetite, energy intake and plasma acylated ghrelin (an appetite stimulating hormone).

Following ethical approval, fourteen healthy males (age, 21.9, $s=2.0$ years, BMI 23.4, $s=2.1$ kg·m⁻², $\dot{V}O_{2max}$ 55.9, $s=6.7$ mL·kg⁻¹·min⁻¹) undertook two main trials: brisk walking (60 min, mean speed 7.0, $s=0.5$ km·h⁻¹, 45.2, $s=7.4\%$ $\dot{V}O_{2max}$) and control, in a random order separated by at least one-week. Exercise and diet were standardised 24 hours prior to each eight-hour trial which commenced in the morning following an overnight fast. Treadmill brisk walking was performed at the beginning of walking trials. *Ad libitum* meals were provided twice during trials (1.5–2 and 5–5.5 h). Energy/macronutrient intake were assessed using manufacturer values. Appetite sensations (hunger, satisfaction, prospective food consumption and fullness) were measured using 100 mm visual analogue scales. Acylated ghrelin was determined from plasma via an enzyme immunoassay (SPIO Bio, France).

Despite inducing a net energy deficit (2006 ± 478 kJ), two-factor ANOVA revealed no

trial or interaction effects (trial \times time) of brisk walking on appetite, energy/macronutrient intake or plasma concentrations of acylated ghrelin ($P > 0.05$). Energy intake on the control and brisk walking trials were similar (control, 9417 ± 2148 kJ; brisk walking, 9372 ± 2565 kJ) therefore walking induced a relative deficit in energy (2051 ± 1356 kJ) as compared with control. Acylated ghrelin AUC (pg·mL⁻¹·8 h) was no different between trials (control, 394.7 ± 55.2 ; brisk walking, 390.2 ± 128.6) ($P=0.9$). These findings demonstrate that brisk walking can induce an acute deficit in energy without eliciting a compensatory response in the appetite stimulating hormone—acylated ghrelin, appetite or energy intake. These findings lend support for a role of brisk walking in successful weight management.

HPHO3-05

Limitations to high intensity exercise prescription in chronic heart failure patients

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Intermittent exercise has been recommended as an effective method of training for chronic heart failure patients (CHF), but prescribing exercise intensity for these patients is fraught with difficulty. Studies have used different methods for defining work and rest phase intensities, e.g. 100% peak work rate in a standard maximal incremental exercise test (Roditis *et al.*, 2007: *European Journal of Cardiovascular Prevention & Rehabilitation*, 14, 304–311) or 50% peak work rate achieved on a specific “maximum short time exercise capacity” test (Meyer *et al.*, 1997: *Medicine and Science in Sports and Exercise*, 29, 306–12), with recovery phases of complete rest or unloaded cycling. The aim of this study was to examine different methods of determining intermittent exercise training workloads in CHF.

Following Local Research Ethics Committee approval, 10 CHF (eight men and two women) in New York Heart Association class II ($n=8$) or III ($n=2$) (age mean 75, $s=8$ years) and seven asymptomatic controls (four men and three women; age mean 67, $s=7$ years) were studied. Two tests to exhaustion were performed on a cycle ergometer; a standard ramp with increases in power output of 10 W every 60 s, and a steep ramp with increments of 25 W every 10 s. Peak work rate and breath-by-breath respiratory gas exchange were determined.

Peak work rates in the standard and steep ramp tests were CHF: mean 88, $s = 33$ W and mean 193, $s = 18$ W; controls mean 151, $s = 46$ W and mean 236, $s = 70$ W respectively. An independent sample t test indicated that, in the steep ramp, CHF achieved a significantly greater increase in standard ramp peak work rate than controls (CHF: mean 227, $s = 36\%$ versus controls: mean 156, $s = 16\%$; $P < 0.01$). Steep ramp $\dot{V}O_{2\text{peak}}$ reached mean 99, $s = 14\%$ of standard ramp $\dot{V}O_{2\text{peak}}$ in CHF, and mean 91, $s = 13\%$ in controls, with repeated measures ANOVA indicating no significant differences between tests in either group ($P = 0.21$). Intermittent work rate determined from 100% standard ramp peak work rate was not significantly different to 50% steep ramp peak work rate in CHF ($P = 0.274$), but was significantly lower in controls ($P = 0.002$).

The relatively higher performance by CHF in the steep ramp relative to the standard ramp compared with control, reflected in both peak $\dot{V}O_2$ and workload, is interesting, and suggests that these patients are less limited by their symptoms in short duration high-intensity exercise. Prescribing intermittent training at 50% steep ramp peak work rate is likely to impose intensities similar to or above 100% standard ramp peak work rate on CHF, but significantly lower than this in asymptomatic individuals.

HPHO3-06

Physical activity levels in neurological populations

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Step counts have increasingly been utilized in both the clinical and research world as a determinant of physical activity in normal populations, yet very little is known about community mobility and physical activity levels in neurological populations. It has been reported that individuals with Multiple Sclerosis engage in less physical activity than sedentary individuals and this reduction in physical activity can lead to subsequent health consequences such as increased weight, osteoporosis, decreased strength and reduced function (McAuley, Motl, Morris, Hu, Doerksen, Elavsky & Konopack, *JF Multiple Sclerosis*, 2007: 13(5), 652–9).

The aim of this study was to measure physical activity in the community in a range of neurological populations using a Step Activity MonitorTM (SAM).

Participants from this study formed part of a larger project looking at exercise in neurological populations. Participants were recruited from Neurological Consultants who specialized in Multiple Sclerosis (MS), Motor Neurone Disease (MND), Muscular Dystrophy (MD) and Parkinson's Disease (PD). Participants were asked to wear a SAMTM (Ortho-Care Innovations, Cyma Corporation) on their preferred ankle for 8 continuous days as per the manufacturer's instructions. Average daily step counts over the 8 day period were compared using a one-way Anova with the 4 groups.

In total 45 individuals (11 PD, 23 MS, 5 MD and 6 MND) were recruited. There were 27 M and 18 F mean age 56.9 years, $s = 9.7$ years. The average daily step count range for the entire 8 days for the whole population was 16–7690 steps; mean 2164 steps, $s = 2001$ steps. In individual neurological conditions, average daily step counts for PD; range 456–7690 steps (mean 3750, $s = 2326$) MS; range 30–4552 steps (mean 1416, $s = 1483$) MD; range 1603–4826 steps (mean 3269, $s = 1501$) and MND; range 16–4215 steps (mean 1202, $s = 1577$).

In this small-scale study there was a large array of daily step counts. Both PD and MD demonstrated higher daily step counts when compared with MS and MND and [$F(3, 40) = 6.643$ $p < 0.001$ $n^2.33$]

The differences in step counts may be a reflection of the individual disease processes prevalent in each group and the difference in physical activity levels warranting further investigation for physical activity in neurological populations.

YPSO1-01

Understanding athletes' experiences of the investment years

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The attainment of an elite standard in sport requires athletes to make considerable life sacrifices (Lavalley & Anderson, 2000: In *Doing sport psychology*, edited by M.B. Anderson. Champaign, IL: Human Kinetics). Similarly, when athletes are recognised as future prospects, they face new and complex psychological demands (Stambulova, 1994: *The Sport Psychologist*, 8, 221–237). Durand-Bush and Salmela (2002: *Journal of Applied Sport Psychology*, 14, 154–171) predicted that athletes progress through four sport-career stages: the sampling, specialising, investment and maintenance years. It is during the investment years specifically that

athletes become focused on one sport that could eventually lead to World Championship and/or Olympic success. Little consideration has been given to the psychological demands athletes experience during this stage of their sports career. Hence, the purpose of this study was to gain an improved understanding of athlete's experiences of the investment years.

With institutional ethics approval, 14 athletes on Olympic and World class development pathways, representing a range of team ($n=7$) and individual ($n=7$) sports, were interviewed about their current experiences in the investment years. In-depth interviews were used as the method of data collection. To ensure trustworthy data, transcribed interviews were content analysed and consensus was reached on all themes by three independent researchers.

Findings indicated that two of the largest themes were "performance pathway culture" and "dependency". The first of these themes represented athletes' ability to cope with the competitiveness and psychological intensity of the development pathway. While some athletes perceived continual rivalry and programme insecurity as motivational, others described such demands as challenging. Further, "dependency" represented athletes' growing attachment to their sport and heightened anxiety during periods of rest and recovery.

This study has important implications for practitioners working alongside athletes during the investment years. The theme of "performance pathway culture" was reported to motivate as well as psychologically drain athletes. Therefore, practitioners and coaches need to equip athletes with strategies to cope with this competitive culture in a positive manner. Further, coaches and practitioners should be aware of the early warning signs of a potentially debilitating dependency towards sport and ensure athletes have strategies in place to achieve appropriate psychological recovery.

YPSO1-02

The experience of well- and ill-being among elite dancers: A test of basic needs theory

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The social-environmental antecedents and motivational mechanisms associated with healthful sport participation have recently been considered within the Basic Needs mini-Theory (BNT), an integral component of the Self-Determination Theory frame-

work (SDT; Deci & Ryan, 2000: *Psychological Inquiry*, 11, 227–68). Research has supported a BNT-based theoretical model in which athletes' perceptions of the motivational climate predict their degree of need satisfaction (autonomy, competence, relatedness), and, in turn, well-being (Reinboth & Duda, 2006: *Psychology of Sport and Exercise*, 7, 269–286). Despite evidence suggesting elite dance participation is not always health conducive (Laws, 2005: *Fit to dance* 2, London: DanceUK), a paucity of research has systematically examined predictors of variability in dancers' welfare. The tenets of SDT are hypothesised to be invariant across settings, yet SDT-driven research in dance contexts remains in its infancy. Grounded in BNT, this study examined a theoretical model of optimal functioning in dance.

With institutional ethical approval 537 full-time dance students (Male $n=133$, Female $n=397$, four unknown; Age mean = 18.80, $s=2.52$) participated in the study. Dancers completed a questionnaire package three times during the school year (T1: September 2007; T2: November 2007; T3: June 2008).

Regression analysis determined whether change in dancers' perceptions of the task- and ego-involving features of their dance climate over the school year predicted variability in need satisfaction, and subsequent changes in positive and negative affect.

Alterations in perceptions of the task-involving features of the motivational climate over the school year positively predicted variability in need satisfaction ($P < 0.001$). Change in perceptions of the ego-involving cues in the dance setting negatively predicted variability in autonomy and relatedness ($P < 0.001$). Hierarchical multiple regressions indicated that, while controlling for the corresponding T1 and T2 variables, T3 positive affect was positively predicted by perceptions of task-involving dance climates ($\beta = 0.37$, $P < 0.001$), autonomy, ($\beta = 0.14$, $P < 0.05$), competence ($\beta = 0.34$, $P < 0.001$), and relatedness ($\beta = 0.20$, $P < 0.01$) at T3. Variability in dancers' experiences of negative affect was predicted by changes in perceptions of ego-involving environments ($\beta = 0.14$, $P < 0.05$) and competence ($\beta = -0.23$, $P < 0.05$). The associations between changes in perceptions of task-involving climates and dancers' positive affect were mediated by variability in the three needs.

Results support the applicability of SDT in dance settings. The endorsement of task-involving and tempering of ego-involving cues in the dance milieu may serve to enhance dancer welfare. Dance environments that foster need satisfaction could be instrumental in promoting healthful dance participation at the elite level.

YPSO1-03**Player and coach perspectives of the psychological qualities relevant to elite pathway rugby**

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Sport psychology researchers have long been interested in identifying the psychological qualities of peak athletic performance (see Krane & Williams, 2006: In *Applied sport psychology: Personal growth for peak performance*, edited by J. M. Williams. New York: MacGraw-Hill). Several recall studies, involving Olympic and World Champions, have provided insights into how athletes develop these qualities (e.g. Durand-Bush & Salmela, 2002: *Journal of Applied Sport Psychology*, 14, 154–171). However, there has been limited research investigating the psychological qualities perceived essential during specific stages of athlete development. Furthermore, the existent studies exploring ideal psychological qualities have tended to adopt the perspective of the athlete, while the perceptions of significant others (e.g. the coach) involved in athlete development, have often been overlooked. The importance of obtaining multiple perspectives is reinforced by investigations that have reported inconsistencies between coaches' and athletes' perceptions (e.g. Vargas-Tonsing, Myers, & Feltz, 2004: *The Sport Psychologist*, 18, 397–414). Therefore, the aim of the present research was to examine the perceived ideal psychological qualities deemed relevant to elite pathway under-16 rugby, and compare perceptions shared by under-16 players with the views expressed by their coaches and players who recently progressed from this level (under-18). Eight focus group interviews were conducted with under-16 ($n=28$) and under-18 ($n=10$) male rugby players, and coaches ($n=7$). Each group consisted of 4–10 participants and lasted between 45 and 60 minutes. 11 first-order and 35 second-order themes emerged from content analysis of the data. Under-16 players generated the broadest set of qualities, and emphasised the importance of determination, self-confidence, and effective regulation of performance state. Under-18 players and coaches were more focused in their consideration of the desired qualities in under-16 district level rugby players. For under-18 players, themes of note included successful adaptation to novel environments and taking responsibility for oneself. Themes perceived critical by coaches included self-aware learning through honest self-appraisal and successful application of coach infor-

mation into physical practice and performance. Altogether, the themes support previous research into the psychological characteristics of elite competitors, and contribute to our understanding of their manifestation in young talented team sport athletes. Moreover, this study extends previous research through the inclusion of the coaches' perspectives of the ideal psychological qualities in their athletes. The information gathered should provide insight into the development of mental skills training programmes for this population.

YPSO1-06**The reliability of a rugby union specific match simulation protocol for forwards**

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Background. Exercise protocols which simulate the demands of team sports have been developed to investigate performance and physiological responses in a controlled environment, but none are specific to rugby union. The purpose of this study was to investigate the reliability of an exercise protocol designed to simulate the demands of rugby union match-play.

Methods. Following Ethics Committee approval, eight male rugby union forwards (mean age 21, $s=3$ years, height 180, $s=4$ cm, body mass 83.9, $s=3.9$ kg) performed a rugby union match simulation protocol on two occasions, at least one week apart, having completed a familiarisation session before the first trial. The 80-min protocol was divided into four 20-min periods, each containing four identical 5-min exercise cycles including 20-m shuttles of walking, jogging, cruising and sprinting, interspersed with simulated rucks, scrums and mauls. Activity type and duration were based on rugby union time-motion analysis data (Roberts *et al.*, 2008: *Journal of Sports Sciences*, 26, 825–832). Within the last minute of every 5-min cycle, participants carried out a timed Performance Test comprising two 9-m sprints, two 9-m tackle bag carries and an agility sprint with a ball followed by 25 s of recovery and then a 15-m sprint. Rating of perceived exertion (RPE) and mean heart rate was obtained after each 5-min cycle. Mean data for both trials were compared for systematic bias and log transformed to calculate percentage coefficient of variation using the methods described by Hopkins (2000: *Sports Medicine*, 30, 1–15).

Results. Total distance travelled was 7078 m, compared with 6418 m estimated via time-motion analysis for the equivalent duration of match-play. No systematic error was found for Performance Test time (trial 1 *versus* trial 2; mean: 17.78, $s=0.71$ *versus* 17.58, $s=0.79$ s, $P=0.120$), 15-m sprint time (mean: 2.69, $s=0.15$ *versus* 2.69, $s=0.15$ s, $P=0.625$), heart rate (mean 160, $s=5$ *versus* 159, $s=5$ beats \cdot min⁻¹, $P=0.427$) or RPE (mean 15, $s=1$ *versus* 15, $s=1$, $P=0.111$). Random error (%CV [95% confidence limits]) was low for all

measures (Performance test, 1.3 (0.9–2.7%); 15-m sprint, 0.9 (0.6–1.8%); heart rate, 2.2 (1.5–5.1%); RPE, 1.6 (1.0–4.2%)).

Discussion. Performance of a rugby specific exercise protocol was reliable over repeated trials in familiarised participants. This protocol is suitable for use in research studies to detect the effect of interventions on changes in rugby union related performance measures.

POSTER COMMUNICATIONS

SBIP1-02

A comparative kinematic analysis of the deadlift performed using the Olympic bar and the Troy-Hex bar

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The deadlift comprises eccentric and concentric phases of muscle activation, and is routinely used by sportsmen as the basis of strength and power training for the back and legs. One of the issues involved in performing the deadlift, is the strain it places on the lower spine. The deadlift is traditionally performed using the Olympic barbell.

There is strong anecdotal evidence that the newly introduced Troy Hex bar reduces the strain on the lower back, and it is routinely used in America in preference to the Olympic barbell in training programmes. This has not however, been proven objectively.

The purpose of the study was to examine the kinematic and electromyographical differences between deadlifts performed using the Olympic barbell and the Troy-Hex bar.

With institutional ethical approval, six rugby union players with experience in performing deadlifts (mean = 3 years, $s = 1.2$) were recruited as participants.

Each subject performed three deadlifts using the Olympic bar and three using the Troy-Hex bar. Three participants performed the deadlift with the Olympic bar first and three performed the deadlift with the Troy-Hex bar first. Participants were allowed 10 min rest between sets. The weight lifted was set at the subject's individual six repetition maximum.

Video data were obtained from a high definition camera from a lateral viewpoint. A kinematic analysis was undertaken to examine the displacement of the bar, the centre of mass of the subject, and the angles of the spine, hips and knees at key positions.

Surface electromyography electrodes were fitted above the right erector spinae, and electrical activity was sampled at 500 Hz. The mean muscle activation for the ascent and descent phases was calculated, and compared.

Erector spinae activation during the descent and ascent phases was found to be significantly less ($P < 0.05$) when using the Troy-Hex bar. Significant differences ($P < 0.05$) were also found between the angles of the trunk, hip, knee angles at key positions.

Results indicate a more erect trunk position was maintained throughout the deadlift performed using the Troy-Hex bar, reflected in reduced erector spinae muscle activation during both the ascent and descent phase of the lift, suggesting a safer method of lifting.

Serious consideration therefore needs to be given to the use of the Troy-Hex bar when performing deadlifts as part of strength and conditioning training programmes.

SBIP1-03

The effect of stature on netball shooting technique, with and without, the presence of a defender

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Tall players are thought to have an advantage when shooting in netball. The purpose of the study was to analyse the effect of stature on netball shooting kinematics, with and without, the presence of a defender.

With institutional ethical approval, 10 female elite netball shooters were recruited as participants. There was a significant difference ($t = -3.598$, $P = 0.004$) between the height of the five tallest shooters, (mean 174.8, $s = 3.70$ m), and the five shortest (mean 164.2, $s = 5.45$ m).

Six successful shots by each participant from a distance of 2 m from the goal post, three with, and three without the presence of a defender, were videoed by a high definition video camera, positioned at right angles to the plane of motion. The defender was positioned 0.9 m from the subject.

A kinematic analysis was undertaken and the data were transferred to SPSS 15 for analysis.

The shorter shooters were found to release the ball at a greater velocity both with ($t = 2.103$, $P = 0.03$), and without ($t = 2.097$, $P = 0.03$), the presence of a defender.

There was no difference in height of release between the two groups in the presence of a defender ($P > 0.05$), but the shorter participants released the ball at a significantly lower height when undefended, ($P < 0.05$).

There was no significant difference between the groups in terms of the angle of release with, or without, the presence of a defender ($P > 0.05$).

There was no significant difference in the horizontal linear displacement of the ball during the "throwing phase" between the groups with, or without the presence of defenders ($P > 0.05$).

There was no significant differences between the groups in terms of knee angle without a defender at any key positions ($P > 0.05$), although in the presence of a defender the shorter shooters bent their knees significantly more ($P < 0.05$) at the start of the throwing phase.

There were no significant differences between the groups in terms of elbow or wrist angle at any key position, with or without, the presence of a defender, ($P > 0.05$).

These results suggest that stature is not a critical factor when selecting elite netball shooters, as successful shorter shooters compensate for their lack of height by changes in kinematics.

SBIP1-04

A comparative kinematic analysis of the bunker shot performed by low and high handicap golfers

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Most of the research into the golf swing has concentrated on the full swing with little attention paid to the short game; in particular the bunker shot. Since this is one of the more difficult skills to master, it would be useful to determine what characteristics are associated with better players, and with successful shots.

Institutional ethical approval was obtained for a two group comparative study to examine the difference in the kinematics of the bunker shot performed by high and low handicap golfers.

Twelve male golfers were recruited, six with high handicaps (22 ± 3.79) and six with low handicaps (3.83 ± 1.94).

Participants were filmed simultaneously from in front, and from the side while performing six bunker shots. The best shot by each subject was selected for analysis. The bunker shot was then broken down into key positions and phases, and the mean kinematics derived for both groups.

A motion analysis was undertaken of the mean angular displacements at key joints during key phases and the mean key positions of the swing, for both groups. Independent t tests were undertaken to examine the significance of any differences between the two groups.

Observational analysis suggested that there were clear differences between the two groups however the greater variability within the high handicap group reduced the power of the statistical analysis. Despite this, significant differences were found between the groups in terms of the angle of the feet ($t = 3.041$, $P < 0.05$) where the skilled golfers angled their feet further to the left of target.

There were also significant differences between the duration of the swing ($t = 3.606$, $P < 0.05$) and the duration of the follow through ($t = 3.284$, $P < 0.05$), where the better golfers had a longer and more complete swing. As a result, there were also significant differences in the angle of the right knee at the top of the follow through phase ($t = 3.284$, $P < 0.05$), where the better golfers performed a more complete follow through.

These findings support accepted coaching practice and anecdotal advice. It is proposed to extend this study to increase the number of participants, and to compare the kinematics of the bunker shot performed by elite golfers in bunkers with wet and dry sand.

SBIP1-05

The relationship between power output in a standing start and sprinting speed in elite male rugby players

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In many sports, the ability to generate high speed of whole body movement over short distances from a standing start is important for successful performance (Cronin & Hansen, 2005: *Journal of Strength and Conditioning Research*, 19, 349–357). The ability to generate horizontal speed rapidly depends primarily on power output. In a standing start, there are two consecutive phases of power output, (i) from the start of movement to toe-off of the rear foot, and (ii) from toe-off of the rear foot to toe-off of the lead foot. Start time is the period between the start of movement and toe-off of the lead foot. Start speed is the horizontal speed of the centre of mass at the end of start time.

The purpose of the present study was to investigate the relationship between leg power and speed in elite senior male rugby players.

Eleven players (Age 25.6 ± 3.7 years, Height 1.84 ± 0.06 m, Mass 101.9 ± 14.1 kg) completed five 10 m sprints with 4 min recovery between trials. Each trial started with the player in a stationary set position, left foot in front of the right on separate force platforms. In each trial, the horizontal force on each foot was recorded at 1000 Hz and the time to 5 and 10 m was measured with photo-cells. The force-time data were integrated to obtain velocity-time data. Instantaneous power-time data were calculated from the product of force and velocity.

Results showed that relative total peak power P_{Tr} (25.82 ± 5.18 W·kg⁻¹) (combined power of both legs relative to body mass) was positively related ($*P < 0.05$) to start speed (3.11 ± 0.18 m·s⁻¹) ($r = 0.92*$), and to average speed over 5 m (4.60 ± 0.19 m·s⁻¹) ($r = 0.74*$) and 10 m (5.50 ± 0.28 m·s⁻¹) ($r = 0.83*$). P_{Tr} was positively related to relative peak power of the left (lead) leg P_{Lr} (11.65 ± 3.78 W·kg⁻¹) ($r = 0.85*$) and right (rear) leg P_{Rr} (9.38 ± 2.82 W·kg⁻¹) ($r = 0.12$). The left (1.64 ± 0.22 m·s⁻¹) and right (1.47 ± 0.17 m·s⁻¹) legs both contributed substantially to start speed (3.11 ± 0.18 m·s⁻¹).

The results suggest that lead leg peak power is the major influence on start speed. No comparable data appears to have been published. Future research should investigate the effect of body position and feet placement on leg power and starting speed in a standing start.

SBIP1-06

Landing from a vertical jump – implication for lower leg amputees

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The physiological and psychological health benefits of physical activity have been proven undisputedly and have formed the basis for encouraging amputees to be more active (Salmon, 2001: *Clinical Psychology Review*, 21, 33–61). Recreational exercise often involves dynamic movements and variations of the vertical jump. Even though landing forms an integral and unavoidable part of the vertical jump, previous research has mainly focussed on the amputees' biomechanical strategies preceding flight (Strike & Diss, 2005: *Prosthetics and Orthotics International*, 29, 39–51). Since the ankle is a major shock attenuator during landing, this study aimed to identify landing strategies adopted by amputees to contend with impact forces in the absence of an ankle joint. Six unilateral transtibial amputee (AMP) participants ($n = 5$ males, 1 female) and 10 able bodied (AB) participants ($n = 9$ males, 1 female) participated in this study with ethical approval from the NHS. All participants were novice jumpers. Data were collected for 10 maximum bilateral countermovement jumps with arms akimbo, using two Kistler (9581 B, 1080 Hz) force platforms synchronised with a 9-camera Vicon (612, 120 Hz) infrared system. The trial with the greatest jump height was chosen for analysis. Landing was defined from the time of touch-down to the time when the centre of mass was at its minimum vertical displacement. The AMP results are presented in order of jump height achieved, with AMP 1 achieving the greatest and AMP 6 the lowest. The AB mean results are presented at the far right of each graph for comparative purposes (Figures 1–3).

Even though the AMP jump heights (mean 0.26, $s = 0.05$ metre) were considerably lower than the average AB jump height (mean 0.43, $s = 0.04$ m), the maximum GRF_(z) and JRF_(Knee & Hip) were similar or higher on the intact side compared to the mean AB values. It is evident that the majority AMP's relied on their intact limb to accommodate the landing forces. Such asymmetry is possibly due

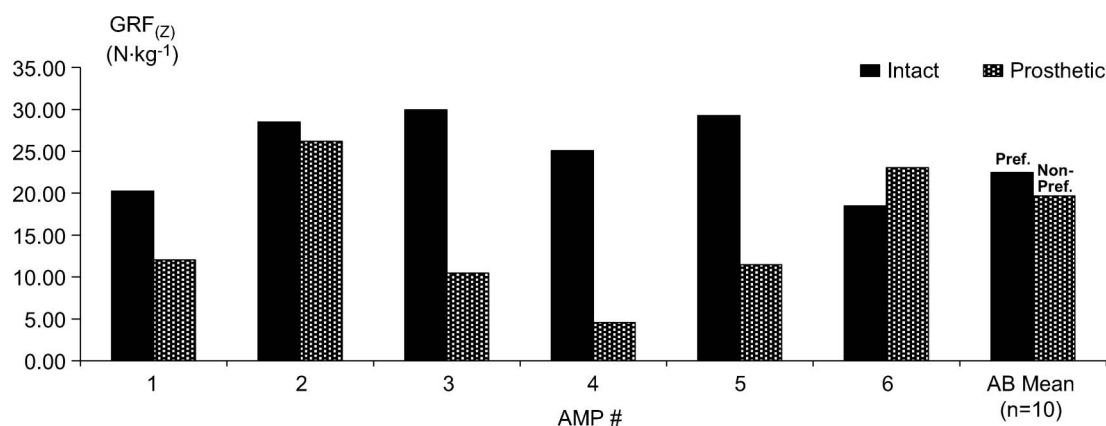


Figure 1. Maximum vertical ground reaction force experienced during landing.

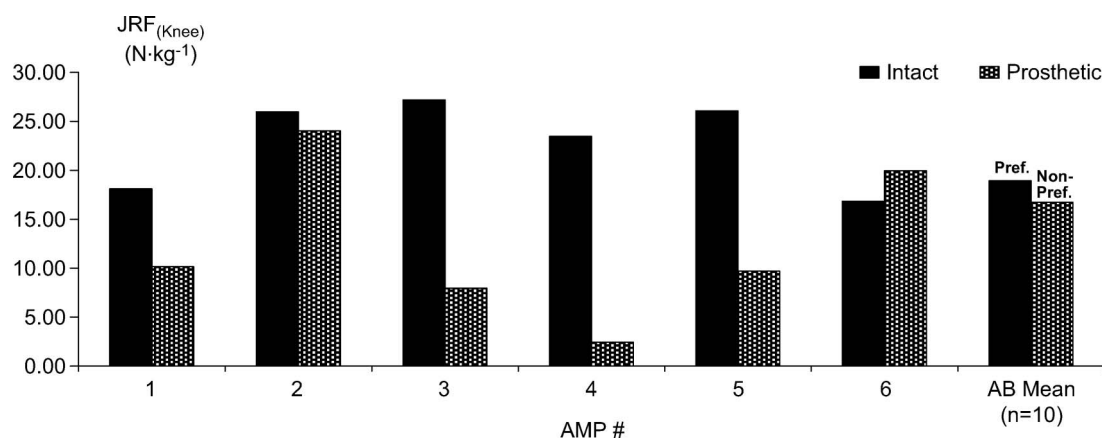


Figure 2. Maximum joint reaction force experienced at the knee.

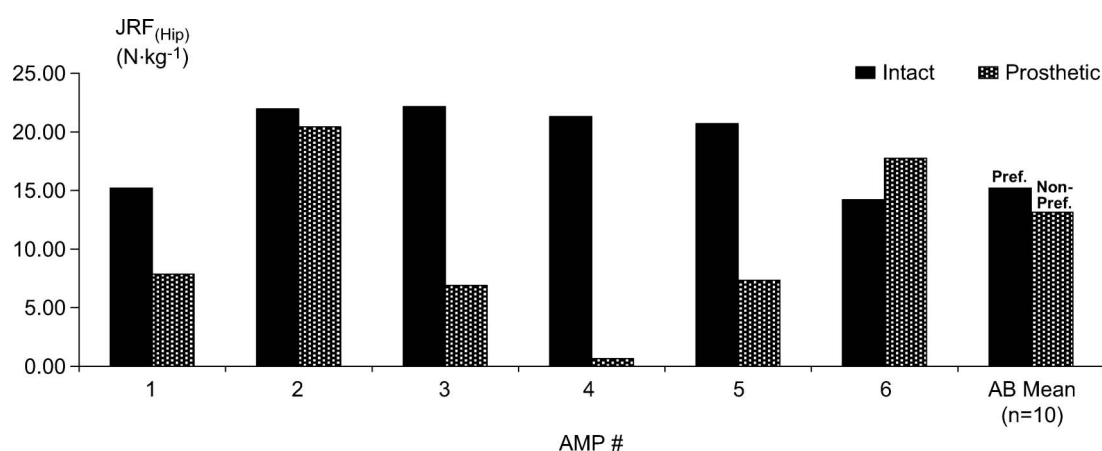


Figure 3. Maximum joint reaction force experienced at the hip.

to the perception or anticipation of unwanted impact forces during landing on the prosthetic side. This might predispose them to injury or long term degenerative damage on the intact side, which is often associated with high impact activities.

SBIP1-07

The effect of breast support on the kinematics of the breast during the running gait cycle

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Breast pain has been related to vertical breast displacement (Mason, Page, & Fallon, 1999: *Australian Journal of Science and Medicine in Sport*, 2, 134–144) and vertical breast velocity (McGhee, Steele, & Power, 2007: *British Journal of Sports Medicine*, 41, 879–883), however, no studies have analysed the kinematics of the breast in three dimensions (3D) and the relationship to breast discomfort. During physical activity, understanding

the kinematics of the breast in all planes may increase our understanding of sports specific breast support requirements. Therefore, the purpose of this study was to investigate multi-planar breast displacement, velocity and acceleration with and without breast support during the running gait cycle, and to establish if this correlates with breast discomfort.

Following Institutional ethical, approval 15 females ran at $2.8 \text{ m} \cdot \text{s}^{-1}$ on a treadmill in no bra, an everyday bra, a compression sports bra and an encapsulation sports bra. A motion capture system tracked the 3D coordinates of breast and body markers during five gait cycles. Following each trial the subject rated her overall breast comfort using a validated visual analogue scale. To establish relative breast displacement, the movement of the trunk in six degrees-of-freedom was eliminated from the movement of the breast; this was derived for velocity and again for acceleration. Spearman's Correlation Coefficient established the relationship between breast kinematics and breast comfort. Qualitative results showed vertical breast displacement, velocity and acceleration peaked at, before and after max-

imum knee bend in the stance phase of the gait cycle, respectively. The trajectories of the displacement and velocity of the breast in all planes were unaffected by increasing breast support, however the magnitudes significantly reduced ($P < 0.02$). The magnitude and trajectory of breast acceleration was unaffected by increasing breast support and showed no correlation to breast comfort. Breast velocity displayed the strongest relationship to comfort ($r = 0.61$). Results showed considerable contributions of mediolateral and anteroposterior kinematics to breast motion, suggesting that future research and bra design may benefit from multi-planar analyses of breast biomechanics. In conclusion, it is suggested that improvements in sports bras should be defined by reductions in breast velocity and displacement.

SBIP1-08

Backswing shape and stickface kinematics in the field hockey hit

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Field hockey players display a range of hitting techniques, but the consequences of this variation are poorly understood. The optimal shape for the backswing, for example, is not known. A flat backswing, as recommended by England Hockey (2005: *Core skills for hockey* Milton Keynes: England Hockey), may be easier to control than a more looped backswing, but the latter may provide a longer distance for acceleration of the stickface. This study aimed to explore the relationship between the shape of the backswing and the subsequent downswing kinematics.

With institutional ethics approval, the hits of 13 experienced female field hockey players (Height mean 1.67, $s = 0.06$ m, Mass mean 64, $s = 6$ kg) were filmed at 200 frames \cdot s⁻¹ with two Locam motion-picture cameras, and three-dimensional coordinates for the stickface were determined using Direct Linear Transformation. The start of the downswing was defined as the final local minimum in the velocity of the stickface before it was accelerated through to impact.

Seven of the players exhibited a pronounced loop in their backswing. This group produced the longest stickface path length during the downswing (mean 2.87, $s = 0.29$ m), as well as the largest stickface velocity at impact (mean 36.6, $s = 1.6$ m \cdot s⁻¹). The remaining six players used a straight backswing in which the stickface path was similar to that of the

subsequent downswing. Four of these adopted a truncated backswing that resulted in a short downswing path length (mean 2.26, $s = 0.06$ m) and a comparatively slow impact velocity (mean 27.9, $s = 1.5$ m \cdot s⁻¹). Two, however, had a downswing path length (mean 2.83, $s = 0.00$ m) comparable to those of the looped swings, and one of these generated an impact velocity of 36.5 m \cdot s⁻¹, indicating that a straight backswing can be effective.

The looped backswings produced larger stickface velocities at the beginning of the downswing (mean 6.3, $s = 1.9$ m \cdot s⁻¹) than the two long straight backswings (1.8 m \cdot s⁻¹ for both). This was not necessarily a major disadvantage for the long straight backswings, because their lower initial velocity probably facilitated a larger velocity increase during the downswing. Future research should investigate the relationships between the velocity at the start of the downswing, the downswing path length, and the velocity added during the downswing.

SBIP1-09

Reliability of nondifferential global positioning system on measurement of distance and elevation on cross-country mountain bike race

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The global positioning system (GPS) has been used as a method to monitor physical activity and access routes during activity (Duncan & Mummery, 2007: *American Journal of Preventive Medicine*, 33, 51–53). Whilst GPS accuracy has been assessed during walking and running in straight and curved courses (Townshend *et al.*, 2008: *Medicine and Science in Sports and Exercise*, 40, 124–132), reliability has not been reported during off-road cycling. The aim of this study was to analyse the variability between and within participants on distance and elevation parameters measured from a nondifferential GPS (nGPS).

With institutional ethical approval six participants (Age mean 27, $s = 4$ years; Height mean 179.5, $s = 4.4$ cm; Mass mean 79.0, $s = 7.4$ kg) competed in a sports category cross country mountain bike race over five laps of 4.5 km. The nGPS unit (Edge 305, Garmin, USA) was programmed to record distance and elevation at one second intervals. The distance and elevation for each lap was time normalised in 51 data points and coefficient of variance (CV) was calculated (MatlabTM) between laps for each

participant (intra-rider) and between participants (inter-rider):

$$CV = \frac{\sqrt{(1/k) \sum_{i=1}^k \sigma_i^2}}{(1/k) \sum_{i=2}^k |\bar{X}_i|}$$

where, k is the number of time intervals over the lap, \bar{X}_i is the mean of the distance and elevation values at the i th interval calculated over laps for intra-rider variability or participants for inter-rider variability, σ_i is the standard deviation of \bar{X}_i for the distance and elevation values over laps (intra-rider variability) or participants (inter-rider variability).

Intra-rider reliability varied across laps and ranged from 2.2–5.6% for distance and 5.3–7.8% for elevation. Paired t test indicate no statistical differences between the CV of distance and elevation. Inter-rider reliability was 5.6% for distance and 6.3% for elevation.

Whilst these values are acceptable for repeatability ($CV < 10\%$) (Menz *et al.*, 2004: *Gait & Posture*, 20, 20–25), they are higher than those previously reported for running using a GPS attached to a receiver for differential corrections (dGPS) (1.83–2.67%) (Schutz & Herren, 2000: *Medicine and Science in Sports and Exercise*, 32, 642–646). This may reflect the more complex decisions of selecting racing line and negotiation of terrain that occurs in cross-country mountain bike racing and the non use of a differential correction GPS. The results therefore suggest that nGPS is reliable on monitoring distance and elevation on off-road cycling.

SBIP1-10

Estimation of peak vertical mechanical power in elite male rugby union players

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Rugby union is an intermittent high intensity sport that requires players to demonstrate high levels of anaerobic capacity, strength, speed and power. The assessment of anaerobic capacity, strength and speed are well established within the literature, however assessment of muscle power is less well developed. Although a force platform can be used to accurately measure lower body instantaneous vertical mechanical power in a countermovement jump (CMJ), it is

not practical for field testing. Consequently, a number of attempts have been made to predict lower body power from the height jumped in a CMJ. However, due to lack of clarity with regard to force platform criterion methods of measuring lower body power, all existing prediction equations have questionable validity.

The purpose of the present study was to develop a force-platform based criterion method of measuring instantaneous vertical mechanical power of the whole body centre of gravity in a CMJ, and to use the method to develop regression equations to predict lower body power in a CMJ.

The criterion method specifies a sampling frequency of 1000 Hz, Simpson's rule for integration of the force record and body weight measurement and start time criterion based on force records during quiet standing prior to jumping. The method was used to measure peak instantaneous vertical mechanical power of the whole body centre of gravity of elite academy, rugby players ($n = 59$, age = 19 ± 1 years, mass = 96.6 ± 11.7 kg, height = 1.86 ± 0.06 m). Body mass and jump height were used as predictor variables and regression equations were developed to predict absolute and relative peak vertical mechanical power output.

Peak estimated power by multiple regression, $P_M (W) = (9026.19 \times \text{jump height (m)}) + (48.96 \times \text{body mass (kg)}) - 2910.9$ ($R^2 = 0.68$, $P < 0.001$, $S.E.E. = 410$ W). Peak estimated power by linear regression, $P_L (W) = (\text{body weight (N)}) \times (10.187 \times \text{jump height (m)} + 1.704)$ ($R^2 = 0.72$, $P < 0.001$, $S.E.E. = 391$ W).

Further studies should investigate the equations' ability to track change and their validity for different populations.

SBIP1-11

Static stretch training improves stretch shortening cycle function

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Caplan *et al.* (2007: *Journal of Sports Sciences*, 25, S72) suggested that range of motion at the hip could be increased during high speed treadmill running after 5 weeks of both static and PNF hamstring stretches. Young (1995: *New Studies in Athletics*, 10, 89–96) proposed a method of determining reactive strength index (RSI) to characterise SSC characteristics specific to running. The aim of this investigation was to evaluate fast SSC function after a period of static stretch training of the lower extremities.

Ten male and ten female physically active participants were randomly allocated into an experimental ($N=10$) and control ($N=10$) group. The experimental group were asked to perform a 30 s static stretch each day for 6 weeks on each the gluteals, quadriceps and triceps surae muscles groups in both legs. The control group were asked not to perform any stretching during this period. Both groups completed three testing sessions (pre-intervention, mid-intervention, post-intervention) where they were required to perform three drop jumps from a box ($h=0.3$ m). They were instructed to jump for maximum height but with minimum contact time on the ground. A force platform (OR-6, AMTI, Massachusetts) was used to record the contact time and flight time of each attempt. Jump height was calculated from flight time using projectile motion relationships. RSI was calculated by,

$$\text{RSI} = \frac{\text{jump height}}{\text{contact time}}$$

Changes from baseline RSI at mid and post intervention were calculated (ΔRSI) and tested for significant main effects using a 2×2 factorial ANOVA (time *versus* group) with repeated measures on one factor (time). Post hoc, Tukey, was used to determine which pairwise comparisons were significant at a confidence level of 95%.

Adherence to the training was very high ($>90\%$) and all participants successfully completed the study. Significant main effects were seen for group ($F(1,9)=11.8$, $P=0.008$), time ($F(2,18)=19.5$, $P=0.002$) and group *versus* time ($F(2,18)=13.6$, $P=0.005$). Post hoc analysis revealed that there was no change in ΔRSI for the control group, but showed ΔRSI to increase from mean 0.093 , $s=0.1 \text{ m} \cdot \text{s}^{-1}$ to mean 0.196 , $s=0.1 \text{ m} \cdot \text{s}^{-1}$ as a result of stretch training ($P < 0.01$).

The results of this study suggest that static stretch training can have a positive effect on muscle performance and that this is due, at least in part, to changes in the fast component of the stretch shortening cycle. Further research is warranted to determine the precise mechanisms by which these improvements are elicited.

SBIP1-12

Kinematic and kinetic changes to gait at different inclines when running at a matched relative metabolic cost

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Swanson & Caldwell (1999: *Medicine & Science in Sports & Exercise*, 32, 1146–1155) investigated the influence of gradient on running biomechanics, finding an increased cadence and stance phase when running on an incline, with corresponding postural changes. However, a fixed velocity was used at all gradients. The aim of this investigation was to determine the influence of gradient on gait parameters when running at matched relative metabolic cost.

Seven male runners (mean age = 30.3, $s=13.7$ years; mean height 1.80, $s=0.06$ m; mean mass 76.9, $s=5.7$ kg) completed two submaximal incremental treadmill tests to determine lactate threshold running velocity at 1% and 6% gradients. Each stage was 4 min (rest = 1 min) with velocity increasing by $1 \text{ km} \cdot \text{h}^{-1}$ between stages. After each submaximal test, participants were allowed 15 min rest before completing a 1 min trial, running at lactate threshold velocity (\dot{V}_{lactate}). During this trial, a Pedar[®] in-shoe pressure device was used to measure ground reaction force at 100 Hz, and the participants was filmed from the side to assess postural changes (frame rate = 50 Hz). Reflective markers (diameter = 25 mm) were located on the toe, heel, ankle, knee, hip and shoulder of the left side of each participant's body and the angles of the foot with respect to the treadmill surface, ankle, knee and hip were extracted at heel strike and toe off. A paired sample t test examined differences between the gradients at a 95% confidence level.

Running velocity decreased significantly ($P < 0.01$) between 1% (mean 3.22, $s=0.22 \text{ m} \cdot \text{s}^{-1}$) and 6% (mean 2.54, $s=0.34 \text{ m} \cdot \text{s}^{-1}$). This change was linked to a significant ($P < 0.01$) reduction in stride length from mean 2.27, $s=0.12$ m at 1% to mean 1.82, $s=0.28$ m at 6%. No significant change in stride rate was observed ($P > 0.05$). Flight time did not change significantly ($P > 0.05$), although contact time increased from mean 0.25, $s=0.02$ s at 1% to mean 0.28, $s=0.03$ s at 6% ($P < 0.01$). No significant postural differences were seen between the two gradients ($P > 0.05$). Peak force did not change significantly ($P > 0.05$), although time to peak force increased significantly from mean 0.106, $s=0.015$ s to mean 0.124, $s=0.014$ s between 1 and 6% ($P < 0.01$).

In conclusion, the data suggests that when running at a matched metabolic cost, changes in running velocity are due to a reduction in stride length and not cadence. Contact time was similar which corresponds to previous literature. However, no kinematic or kinetic changes were observed, suggesting that runners maintain their normal running style on an incline if relative metabolic cost is matched.

SBIP1-13

Measurement of ground contact times in sprinting using in-shoe pressure sensors

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Ground contact time is an important variable in the biomechanical study of sprint performance. Previous research has linked contact time to force production during the ground phase, and has found that if sufficient force can be created rapidly, contact time can be minimised (Mann, 1985: In *The elite athlete*, edited by N. Butts, T. Gushiken, & B. Zarins. Jamaica, NY: Spectrum Publications). Furthermore, a negative relationship has also been identified between contact time and sprint velocity (Weyand *et al.*, 2000: *Journal of Applied Physiology*, 89, 1991–1999). The accurate measurement of contact times at sufficient resolution throughout a sprint would provide useful data for coaches and biomechanists. The aim of this study was to develop and evaluate an in-shoe method of obtaining contact times during a sprint run.

With institutional ethical approval, one trained male 400 m runner gave written informed consent and performed six maximal starts to 30 m from blocks. Ten to twelve contacts per run were measured. Data were gathered using custom-built force-sensitive resistor (FSR) pressure insoles (~900 Hz) and synchronised CODA (800 Hz) and force platform (1000 Hz; first contact only). Contact times from FSR sensors were compared to force and CODA data. Root mean squared difference in contact time between FSR and force data for the first step in each run was 0.0033 s (1.2% of mean contact time from force data), and between FSR and CODA for all measured steps was 0.0025 s (1.4% of mean contact time from CODA data).

Results showed a good level of agreement between the three methods of contact time measurement investigated. Typically, the number of contacts that can be measured in a sprint is limited by the number of force plates available or the maximum volume covered by an automatic motion analysis system or high speed camera. Measuring contact times with insoles makes it possible to gather accurate data from every contact without causing the subject discomfort or interfering with sprint technique. These results suggest that the FSR sensors are a suitable substitute for force and kinematic measures of contact time. Future work will validate the accuracy and reliability of the insoles with a larger sample of sprinters and

further investigate the relationship between contact times and performance.

SBIP1-14

Effect of workload on three-dimensional cycling kinematics

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A comprehensive full-body cluster marker set and 6-DOF model was developed to investigate the effects of workload on three-dimensional cycling kinematics. 20 male competitive cyclists (mean 35.1, $s=9.5$ years, 1.79, $s=0.08$ m in height, 75.0, $s=7.5$ kg mass) completed a graded exercise test to exhaustion on an SRM ergometer using a 25 W·min⁻¹ ramp protocol. Motion capture took place by means of a Qualisys 9-camera Infra-red motion capture system sampling at 240 Hz 45 s into every minute until subjective exhaustion was reached. Heart rate, muscle activity, tissue oxygenation status, torque, and cadence were also recorded simultaneously. Cluster plates were positioned on the right shank, thigh, upper arm and forearm, and additional trunk cluster plates on the pelvis, lumbar, mid-thoracic and thoracic regions. The workload-induced changes in kinematic data were analysed in Visual 3D with reference to the position of the pedal after top dead centre. Specifically the angular kinematics of the ankle, knee, hip, pelvis, lumbar, mid-thoracic, thoracic, shoulder and elbow were analysed in flexion-extension and where appropriate ab-adduction/lateral flexion, and axial rotation.

Increased workload caused significant increases in elbow flexion ($P < 0.05$), axial rotation between the mid-thoracic and thoracic cluster plates ($P < 0.05$), lateral flexion and axial rotation between the lumbar and mid-thoracic plates, and between the pelvis and lumbar plate ($P < 0.05$), and of flexion-extension of the pelvis ($P < 0.05$).

Maximum and minimum hip angles were unaffected by workload, although the crank angle at which they occurred significantly decreased ($P < 0.05$). In contrast the crank angle at which maximum knee flexion and extension occurred did not change with increasing workload ($P > 0.05$) although maximum extension of the knee significantly increased ($P < 0.05$).

Maximum ankle dorsi and plantar flexion varied considerably between cyclists due to preferred individual pedalling styles. However maximum plantar flexion significantly decreased with increas-

ing workload ($P < 0.05$), and maximum dorsi flexion decreased non-significantly ($P > 0.05$).

The development of a unique marker cluster set enabled detailed analysis of full-body cycling kinematics, and showed that experienced competitive cyclists demonstrate a well-developed and consistent motor programme regarding the lower-limb kinematics, and also that the spinal kinematics appear to act as a torque-induced engine by means of increases in axial rotation magnitude in the lumbar, mid-thoracic and thoracic spinal segments as workload is increased.

SBIP1-15

A new progression scale for common lower limb rehabilitation tasks

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The treatment of most soft tissue injuries tend to have similar goals: to treat initial pain and swelling, restore full range of motion and return to full strength. One of the key problems is that there appears to be a gap between the traditional eccentric strength programme and progression to normal locomotive and athletic activities. Taking the example of Achilles tendinopathy, progression of rehabilitation protocols has traditionally been based on anecdotal advice and there is a shortage of empirical evidence. Although numerous studies have provided a useful insight into a variety of individual movements, they do not indicate how one movement compares to another. The aim of this study was to analyse the common locomotive and athletic training activities used in rehabilitation to produce a continuum based on magnitude and rate of application of ground reaction force.

Twenty-four injury-free participants (13 males, 11 females) carried out 12 different movements (bodyweight isometric calf strengthening exercise, weighted isometric calf strengthening exercise, walking, jogging, sprinting, hopping, bodyweight squat, weighted squat, isometric squat, countermovement jump, squat jump and drop jump). Force data collected via a Kistler force platform was used to quantify peak vertical force, peak vertical force relative to body weight and rate of force development. A Vicon motion analysis system provided kinematic data.

Repeated measures ANOVAs indicated that there were significant interactions of task and peak vertical force ($F_{3,22, 74.16} = 145.68$, $P = 0.001$), task and peak vertical force relative to body weight ($F_{2,98, 68.42} = 154.63$, $P = 0.001$) and task and rate of force

development ($F_{3,25, 74} = 96.76$ $P = 0.001$). Pairwise comparisons of all exercises show that for all force measures the majority of tasks were significantly different from one another ($P < 0.05$). The effect of kinematic variability was evaluated using the Pearson Correlation coefficient.

A clear progression of exercises was seen in both peak force measures, whilst rate of force development measures showed three distinct groups of low, medium and high rates. Combining the data from the measures lead to the grouping the exercises into early (walking, isometric calf load, weighted isometric calf load, bodyweight squat and isometric squat), mid (jogging, hopping and weighted squat) and late stage (sprinting and all jumps) rehabilitation. We suggest that practitioners use this ranking to prescribe appropriate exercises for particular stages of rehabilitation.

SPHP1-16

Effectiveness of 3 and 5 mm wetsuits after 16°C cold water immersion for 90 minutes

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There is increased conductive heat loss in the human body during cold water immersion and different types of wetsuits are used to delay this loss of heat. The purpose of this study was to investigate the effectiveness of 3 and 5 mm wetsuits to cold water immersion of 16°C (British summer sea temperature) for 90 min.

Following ethical approval from the University of Hertfordshire, eight male participants (age 22 ± 1.4 years, height 177.4 ± 0.7 cm, mass 74.1 ± 0.1 kg, total body fat $11.7 \pm 6.3\%$) completed three trials in a randomly assigned cross-over design. Each consisted of cold water immersion of 16°C for 90 min duration with either; no wetsuit (NWS), 3 mm wetsuit (3 mm WS) or 5 mm wetsuit (5 mm WS). Rectal temperature (T_{re}), mean skin temperature (\bar{T}_{sk}) and mean body temperature (\bar{T}_b) were measured continuously. Thermal comfort (TC), thermal sensation (TS) and heart rate (HR) were measured at 15 min intervals. Grip strength was measured pre and post cold water immersion using a handgrip dynamometer. Total body fat was measured by bioelectrical impedance. Data were analysed using repeated measures ANOVA and relationships between variables by Pearson's product moment correlation.

Results demonstrated greater maintenance of T_{re} during the 3 mm WS ($-1.3 \pm 0.2^\circ\text{C}$) and 5 mmWS trials ($-0.9 \pm 0.2^\circ\text{C}$) in comparison with NWS

($-2.1 \pm 0.4^{\circ}\text{C}$; $P=0.01$), with no difference between wetsuits ($P=0.76$). At 90-min \bar{T}_{sk} was lower with NWS ($21.8 \pm 8.3^{\circ}\text{C}$; $P=0.00$) versus the 3mmWS ($27 \pm 4.3^{\circ}\text{C}$) and the 5 mmWS ($28 \pm 4.2^{\circ}\text{C}$), with no difference between wetsuits ($P=0.25$). Similarly, \bar{T}_{b} was lower with NWS ($35.1 \pm 0.2^{\circ}\text{C}$; $P=0.00$) in comparison with 3 mm WS ($35.8 \pm 0.8^{\circ}\text{C}$) and 5 mmWS ($35.9 \pm 0.1^{\circ}\text{C}$), with no difference between wetsuits ($P=0.62$). TS was greater with 3 mm WS and 5 mm WS versus NWS ($P=0.03$) but there was increased TC in the 5 mm WS versus the 3 mm WS and NWS ($P=0.05$). HR was higher with NWS ($83 \pm 6 \text{ b} \cdot \text{min}^{-1}$; $P=0.00$) versus the 3mm WS ($70 \pm 2 \text{ b} \cdot \text{min}^{-1}$) and 5 mm WS ($69 \pm 3 \text{ b} \cdot \text{min}^{-1}$), with no difference between wetsuits ($P=0.99$). Grip strength tended to be greater across 90-min in the 3 mmWS (41 ± 6.3 kilo) and 5 mm WS (40 ± 7.9 kilo) versus NWS (35.2 ± 9.5 kilo; $P=0.06$). There was a moderate relationship between total body fat and the decline in T_{re} in the NWS trial ($r=0.74$).

These results suggest that the application of a wetsuit maintains core body temperature during 90 min exposure of 16°C cold water immersion. Furthermore, there is no physiological difference between using a 3 mm and 5 mm wetsuit but greater thermal comfort was reported using the 5 mm wetsuit.

SPHP1-17

The effect of heat acclimation on thermoregulatory responses during upper body exercise

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Heat acclimation involves performing exercise in a hot environment for 7–10 days resulting in increased sweat rate, reduced heart rate and body temperature at a given exercise intensity (Rowell, 1974: *Physiology Reviews* 54, 75–159). The responses to heat acclimation have only been reported for lower body exercise. As differences exist in thermoregulatory responses between upper and lower body during sub-maximal exercise (Sawka *et al.*, 1984: *European Journal of Applied Physiology and Occupational Physiology*, 52, 230–234) differences in thermoregulatory adaptations with heat acclimation may also be expected. The aim of the study was to examine the effect of 7 days of heat acclimation on thermoregulation during upper body exercise.

Following University ethical approval 11 healthy, upper body trained male participants volunteered for

this study. Participants completed 7 days of heat acclimation ($35.4 \pm 0.9^{\circ}\text{C}$ and $43.6 \pm 5.8\%$ humidity) involving 30 min of arm exercise at 60% peak power (determined from a maximal exercise test) followed by 30 min of passive recovery on each occasion. Days 1 and 7 of heat acclimation were used to determine thermoregulatory adaptations. Rectal and skin temperatures were recorded at rest, during exercise and recovery (Grant Instruments) along with calf volume (strain gauge plethysmography; Hokanson). Local sweat rates (forehead, back, thigh and calf) were measured using a quantitative sweat measurement system (Q Sweat, Minnesota). Heart rate (HR) was continually monitored (Polar Accur-ex). Data were analysed by a two factor, repeated measures analysis of variance (time \times day).

HR was lower on Day 7 ($160 \pm 14 \text{ beats} \cdot \text{min}^{-1}$) compared to Day 1 ($165 \pm 15 \text{ beats} \cdot \text{min}^{-1}$; $P < 0.05$). The onset of sweating was initiated earlier during exercise on day 7 compared to day 1 ($P < 0.05$). Forehead and thigh sweat rates were greater on day 7 of heat acclimation compared to day 1 ($P < 0.05$). Rectal temperature was lower during exercise on Day 7 compared to Day 1 ($P < 0.05$) with no differences at rest between trials ($P > 0.05$). Calf volume decreased more during exercise on Day 7 when compared to Day 1 ($P < 0.05$).

The results suggest there are similarities between thermoregulatory adaptations gained during upper and lower body heat acclimation such as a reduced core temperature. The greater decrease in calf volume may be a result of increased vasoconstriction compensating for an increase in skin blood flow thus reducing venous pooling.

SPHP1-18

Repeated cold water immersion and the adaptation to eccentric exercise

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Eccentric contractions are a potent stimulus for neuromuscular adaptations; however, when contractions are unaccustomed, temporary exercise-induced muscle damage (EIMD) is precipitated, resulting in reduced muscle function and increased muscle soreness. The repeated bout effect (RBE) is the adaptation resulting from a single bout of eccentric exercise and results in significantly less soreness and attenuated reduction in muscle function in repeated bouts of exercise. A number of interventions following the initial bout have been used in an attempt to reduce the

negative effects associated with EIMD (Howatson *et al.*, 2007: *International Journal of Sports Medicine*, 28, 557–563). One common intervention is cold water immersion (CWI); although the effects of this treatment on muscle damage are equivocal, it is unknown if this intervention has any effect on the RBE. Therefore the aim of this investigation was to elucidate the influence of CWI on the adaptation from eccentric exercise using the RBE paradigm.

Following institutional ethics approval, 18 male participants volunteered to participate in the investigation. Participants completed 100 drop jumps and were then randomly assigned to a treatment or control group. The treatment intervention was administered immediately after, 24, 48 and 72 h post-exercise and consisted of a 12 min CWI (15°C). After two weeks, a second bout was completed but no intervention was given. Isometric force (MVC), muscle soreness (DOMS), serum CK, range of motion (ROM) and calf girth were recorded pre and post-exercise (except CK), 24, 48, 72 and 96 h post-exercise before and following both bouts. Dependent variables were analysed using a mixed model repeated measures. *Post-hoc* analyses were used to identify differences between bouts and treatments.

Following the initial bout there were significant increases in CK and DOMS and a significant decrement in MVC ($P < 0.001$), but there were no differences between treatments. The decrement in MVC and the increase in DOMS were significantly attenuated following the second bout ($P \leq 0.002$), but again there were no differences between treatments. In conclusion, the administration of repeated CWI following damaging exercise, whilst of no apparent benefit as a treatment strategy, does not appear to inhibit the RBE which is an important adaptation from a single bout of damaging eccentric biased exercise.

SPHP1-19

Placebo effects of caffeine on resistance exercise performance

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The placebo effect is a favourable outcome arising from the belief that one has received a beneficial treatment (Clark *et al.*, 2000, *Medicine and Science in Sports and Exercise*: 32, 1642–1647). Despite evidence elsewhere that the placebo effect impacts on a range of variables its influence related to exercise performance has received scant attention (Beedie *et al.*, 2006: *Medicine and Science in Sports and Exercise*, 38, 2159–2164). Although studies have

documented performance enhancing effects of placebo in aerobic exercise, it appears no studies have examined the placebo effect on resistance exercise. The aim of this study was to examine placebo effects of caffeine on resistance exercise performance.

Following ethical approval, 12 males (Mean age = 22.6, $s = 6.1$ years) volunteered to participate. Participants were informed that they would perform one set of single leg, leg extension exercise to failure at 60% 1RM in three conditions: control, placebo and 3 mg · kg⁻¹ caffeine. However, no caffeine was administered in the study, instead participants consumed 250 mL of an artificially sweetened drink, in both conditions, 1 h before testing. Following completion of each trial the number of repetitions completed was taken as a performance measure and RPE responses were assessed using the Borg 6–20 scale (Borg, 1970: *Scandinavian Journal of Rehabilitation Medicine*, 2, 92–98) for both the active muscle (RPE-A) and the overall body (RPE-O). One Way repeated measures ANOVA was used to examine any changes in repetitions to failure over the three trials and a two (RPE region) by three (Trials) repeated measures ANOVA was used to examine any differences in RPE between trials.

Participants completed significantly more repetitions in the “caffeine” condition compared to control and “placebo” conditions ($F_{2,22} = 15.86$, $P = 0.0001$). RPE for the active muscle was significantly higher compared to RPE for the overall body across trials ($F_{1,11} = 35.46$, $P = 0.0001$) and RPE was lower in the condition where participants thought they had received caffeine compared to control and “placebo” conditions ($F_{2,22} = 3.68$, $P = 0.04$).

These results agree with research that investigated placebo effects in aerobic based exercise (Beedie *et al.*, 2006: *Medicine and Science in Sports and Exercise*, 38, 2159–2164). In this instance once participants consumed a substance they believed to be caffeine they completed substantially more repetitions to failure and reported lower RPE during a single leg, leg extension than when they consumed a substance they believed to be placebo or in the control condition.

SPHP1-20

Validity of a squash-specific test of repeat sprint capability

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Despite the multiple-sprint nature of squash (Vučković *et al.*, 2004: In *Science and racket sports III*, edited

by A. Lees & J. Kahn. Oxon: Routledge), there are no published squash-specific tests of this aspect of performance. Accordingly, the purpose of this study was to examine the validity of a squash-specific test designed to assess repeat-sprint capability.

With institutional ethics approval eight trained male squash players (age mean 25, $s = 5$ years; stature 1.77, $s = 0.04$ m; body mass 72.8, $s = 7.8$ kg, $\dot{V}O_{2\max}$ 56.8, $s = 5.5$ ml·kg⁻¹·min⁻¹) and eight non-squash players (trained footballers) (age mean 22, $s = 3$ years; stature 1.79, $s = 0.09$ m; body mass 82, $s = 12$ kg, $\dot{V}O_{2\max}$ 51.4, $s = 5.1$ ml·kg⁻¹·min⁻¹) who were habituated to the procedures, performed on separate days Baker's 8 × 40 m sprints and a squash-specific repeat-sprint test. Performance was recorded as the sum of individual sprint times in each test. Six squash players and six footballers repeated the tests seven days later to assess reproducibility of measures using typical error and associated 90% confidence intervals. In addition, two England Squash coaches independently ranked the squash players using knowledge of the player and recent performances in local leagues.

Performances on the squash-specific (TE 6 s, 2.2%, 90% CI 4–13 s; TE 6 s, 2.3%, 90% CI 4–12 s) and Baker's test (TE 1 s, 1.6%, 90% CI 1–2 s; TE 1 s, 1.7% 90% CI 1–3 s) were reproducible in squash players and footballers respectively and did not differ (independent t tests) (squash players mean 72.9, $s = 3.9$ s, footballers mean 72.9, $s = 2.81$ s $P = 0.969$) on Baker's test. However, squash players (mean 232, $s = 32$ s) outperformed footballers (mean 264, $s = 14$ s) on the squash-specific test ($t_{14} = 2.56$, $P = 0.02$, Cohen's d effect size = 1.4). Performance on the Baker's and squash-specific tests were related in squash players (Pearson's $r = 0.98$, $P < 0.001$) but not in footballers ($r = -0.08$, $P = 0.87$). There was a relationship between squash-player rank and performance on the squash-specific test (Spearman's $\rho = 0.79$, $P = 0.02$) but not on Baker's test ($P = 0.16$).

The squash-specific test discriminated between both groups with similar non sport-specific repeat-sprint capability and in squash players. In conjunction with the relationship between test performances, the results suggest that the squash-specific test is a valid measure of repeat-sprint capability in squash players.

SPHP1-21

Determinants of squash fitness and performance

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Squash is a repeat-sprint sport, where success depends on physical, technical, tactical and motor skills (Lees, 2003: *Journal of Sports Sciences*, 21, 707–732). However, it is unclear which of these factors best relate to performance or which fitness components determine squash-specific repeat-sprint capability. Accordingly, the purpose of this study was twofold: (1) to examine relationships between player rank and performance on a battery of squash-specific tests of racket accuracy and fitness and (2) to investigate fitness components associated with squash-specific repeat-sprint capability.

With institutional ethics approval 18 male squash players (Age mean 32, $s = 12$ years; Stature 1.79, $s = 0.05$ m; Body mass 77, $s = 10$ kg) who were fully habituated to procedures participated. Participants were all regular competitors in the Northumberland regional squash leagues. Playing standard ranged from premier to third division with all participants having at least 2 years of experience at their present level. In randomised order, participants completed squash-specific tests of shot accuracy, $\dot{V}O_{2\max}$ (from an incremental test using squash movements and breath-by-breath determination of $\dot{V}O_2$), endurance (performance time on the incremental test), speed and agility and repeat-sprint capability. Two England Squash qualified coaches independently ranked the squash players using knowledge of the players and recent performances in local leagues. Relationships between test scores, player rank and repeat-sprint capability were examined using Spearman's ρ and Pearson's correlations respectively.

Player rank was correlated with endurance on the squash-specific incremental test ($\rho = -0.71$, $P = 0.007$) and with squash-specific repeat-sprint capability ($\rho = 0.82$, $P = 0.001$). Correlations between rank and $\dot{V}O_{2\max}$ ($\rho = -0.41$, $P = 0.17$), speed and agility ($\rho = 0.54$, $P = 0.06$) and shot accuracy ($\rho = -0.48$, $P = 0.09$) were in the anticipated direction but not significant. Squash-specific $\dot{V}O_{2\max}$, endurance and speed and agility correlated with squash-specific repeat-sprint capability ($r = -0.57$, $P = 0.044$; $r = -0.63$, $P = 0.021$; $r = 0.84$, $P < 0.001$ respectively).

Squash-specific endurance and repeat-sprint capability were related to player rank. There were moderate but non-significant correlations between rank, $\dot{V}O_{2\max}$, speed and agility and shot accuracy. Repeat-sprint capability was associated with speed and agility, $\dot{V}O_{2\max}$ and endurance capacity. The results suggest that both endurance and repeat-sprint capacity are important for success in squash.

SPHP1-22**The effect of static and dynamic stretching on vertical jump performance using electromyographic assessment of the vastus medialis**P. Hough¹, E. Z. Ross², & G. Howatson¹¹*St. Mary's University College, Twickenham and*²*Brunel University, West London, UK*

It is a common practice for athletes to incorporate some form of stretching in their warm-up routines. Two of the most common techniques are static and dynamic stretching. Results of recent research have demonstrated that whilst static stretching can reduce muscular performance, dynamic stretching can enhance it (Yamaguchi & Ishii, 2005: *Journal of Strength and Conditioning Research*, 19, 677–683). The underlying mechanisms for this increase are unclear, although increased neuromuscular facilitation may be a contributing factor. Therefore, the purpose of this study was to examine the effects of static and dynamic stretching on muscular performance and electromyography (EMG) activity.

Following institutional ethical approval, eleven healthy male university students (Age mean 21, $s = 2$ years) volunteered to participate. Participants conducted three separate stretching conditions (no stretching, static stretching, and dynamic stretching), on three occasions, separated by a minimum of 48 h, in a randomised cross-over design. Experimental groups carried out 30 s stretches on individual lower limb muscle groups, whilst the no stretching group were seated for an equitable time. Following each stretching protocol, maximal vertical jump height (concentric-only jump) and the associated root-mean-squared (RMS) EMG activity from m. vastus medialis during the vertical jump were recorded. The average of three trials was used for data analysis. A repeated measures ANOVA and Bonferroni *post-hoc* test showed a significant treatment effect for jump height, where dynamic stretching was greater than both no stretching and static stretching ($P < 0.05$) and no stretching was greater than static stretching. EMG indicated a non-significant decrease between no stretching and static stretching and a significant increase between static and dynamic stretching ($P < 0.05$).

The results demonstrated that static stretching has a negative influence on vertical jump performance whereas dynamic stretching increases vertical jump performance. In addition there was a concomitant increase in EMG signal amplitude for the dynamic stretching condition. The reduction in vertical jump performance after static stretching may be due to

alterations in the viscoelastic properties of the muscular-tendon unit. It has been previously reported that muscular performance may have increased after dynamic stretching due to increased post-activation potentiation (Gossen & Sale, 2000: *European Journal of Applied Physiology*, 83, 524–530). The findings of this study highlight that an increase in performance following dynamic stretching may be due, at least in part, to increased neuromuscular drive. Therefore, dynamic stretching may be beneficial prior to conducting strength and power activities, whereas static stretching appears to be contra-indicated.

SPHP1-23**The validity and sensitivity of urine colour as a field based method to monitor hydration status**

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The aims of this study were to assess the validity of Urine colour (U_{col}) as a field based measure of hydration status in comparison to Urine specific gravity (U_{sg}) assessed by refractometry; and to assess the sensitivity of U_{col} in monitoring changes in hydration status. Dehydration is associated with decreased physical performance, decreased cognitive functioning and in severe cases coma and death. Maintaining fluid balance is critical during prolonged exercise or work in the heat. Thirst does not give an adequate indication of hydration status nor does it provide a useful cue to drink. Therefore the monitoring of hydration status is useful for improving athletic performance but critically important for ensuring the safety of an athlete or worker. Hydration status may be assessed from the specific gravity of urine, (Armstrong, 2000: *Performing in extreme environments*. Champaign, IL: Human Kinetics.) although this requires specialist equipment and some technical training. Alternatively, Armstrong (2000) suggests that the colour of urine may be used as an index of fluid balance and therefore hydration status and provide a simple method which may be used by athletes or workers with minimal training.

Following ethical approval and informed consent, 28 participants were recruited to the study. Data were collected during a three day climbing expedition in Northern France. On the first morning of the expedition, participants were weighed in their shorts and t-shirts and mass recorded using Seca scales. Participants were instructed to collect a mid stream urine sample during their first urination of the day. U_{col} was assessed by the investigator and specific gravity recorded using refractometry. Following

baseline measures, participants completed a three day self supported climbing expedition. Personal equipment carried weighed 17.30 \pm 5.1 kg including 3.0 L of water. A second "water drop" (3.0 L) was completed on the afternoon of the second day. Day time temperature peaked between 28–32°C and night-time temperatures were as low as 5°C. Urine was collected again on the morning of the third day and participants' mass was recorded on their return to base camp.

Baseline measurement of U_{col} showed a strong positive relationship with specific gravity as measured using refractometry ($r^2 = 0.85$, $P < 0.001$). Following the expedition, body mass was significantly reduced by 0.58 kg, ($t_{(27)} = 3.603$, $P < 0.001$). U_{col} showed a significant increase from 4.86 \pm 2.17 to 6.18 \pm 0.98 Units of measurement? ($Z = -2.546$, $P = 0.11$) and U_{sg} increased from 1.018 \pm 0.01 to 1.022 \pm 0.01 ($t_{(27)} = -2.469$, $P = 0.02$). In addition the change in U_{col} showed a strong positive relationship with the change in U_{sg} ($r_s = 0.724$, $P < 0.001$), however, change in neither U_{col} nor in U_{sg} correlated with change in body mass.

In conclusion, this study has shown that the assessment of hydration status using U_{col} is a valid field based measurement which is sufficiently sensitive to monitor changes over time. These findings are more impressive given the small reduction evidenced in body weight. It is recommended that athletes and workers exercising in a hot environment monitor U_{col} to optimise performance and avoid the deleterious effects of dehydration.

SPHP1-25

Punch acceleration and oxygen consumption

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The physiological demands of the work-recovery cycles that typify boxing are poorly understood, as are the aerobic costs of throwing punches and movement within the ring. The aim of this study was to validate the use of a dual axial accelerometer attached to a boxing heavy bag to determine whether it can differentiate in intensities with which the bag is hit. Furthermore, it was seen whether a relationship between punch acceleration and oxygen consumption ($\dot{V}O_2$) existed.

With institutional ethics approval, 14 participants (20.3, $s = 1.4$ years; height 1.73, $s = 0.06$ m; body mass 72.6, $s = 13.9$ kg) gave their written, informed consent and performed a familiarisation and experimental trial. Participants followed a pre-set

combination of punches and performed 3×3 minute rounds at a low, moderate and high intensity with a 1 min rest between rounds.

Punch acceleration was measured using a dual-axial accelerometer (ADXL210E, Analog Devices, USA) attached to the rear of a boxing heavy bag. Accelerometer output (measured in volts (V)) was sent via an amplifier and data acquisition unit to a Spike 2, version 5.19-computer program. Throughout testing $\dot{V}O_2$, ventilation (\dot{V}_E) and RER were determined using continuous 1 min Douglas Bag samples. Heart rate was monitored continuously. Data are expressed as mean \pm s, with two-sampled t tests used to determine differences in variables between the rounds and Pearson's Correlations used to establish relationships between punch acceleration and $\dot{V}O_2$.

For all variables measured, values increased in accordance to increased exercise intensity. Significant differences ($P < 0.05$) were found between rounds one and two and rounds one and three, however, no significant differences were found between rounds two and three for all variables. The mean $\dot{V}O_2$ was 2.8, $s = 0.5$, 3.3, $s = 0.6$ and 3.4, $s = 0.7$ L \cdot min $^{-1}$ and mean punch acceleration was 2.17, $s = 0.46$, 2.76, $s = 0.70$ and 3.06, $s = 0.71$ V for rounds one, two and three, respectively. R-values between these variables were 0.48 ($P = 0.08$), 0.66 ($P = 0.01$) and 0.75 ($P = 0.002$) for the three rounds, respectively.

The accelerometer successfully detected the changes in intensity at which the heavy bag was hit. As the intensity at which the bag was hit increased, the relationship between punch acceleration and $\dot{V}O_2$ grew stronger. It is uncertain what contribution throwing a punch has to the total oxygen consumption thus, future research will attempt to determine the oxygen cost of the boxers movement around the heavy bag.

SPHP1-26

The effects of increasing cadence on peak physiological parameters during incremental arm crank ergometry

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Increased cadence during arm ergometry reduces local fatigue (Price *et al.*, 2007, *Applied Physiology Nutrition and Metabolism*, 32, 686–692). To date, only fixed or self-selected cadences have been prescribed. The aim of this study was to examine

the effects of increasing cadence on peak physiological responses during incremental arm ergometry.

Ten healthy non-specifically trained males (mean age 20.7, $s=0.8$ years; mean body mass = 77.3, $s=7.6$ kg) gave written consent to take part in the study which had received University ethics committee approval. Participants undertook a preliminary incremental test for peak minute power (PMP) on an electronically braked arm ergometer (initial intensity 50 W for 2 min, subsequent increases of 20 W · 2 min⁻¹, 70 rev · min⁻¹). Two further incremental exercise tests were undertaken on separate days with at least 2 days between each and were counter-balanced. One involved arm cranking at an initial workload of 40% PMP obtained in the preliminary test with increases of 10% PMP every 2 min at 70 rev · min⁻¹ (70 RPM). The other involved the same protocol (same increments in PMP) but with an initial cadence of 50 rev · min⁻¹ increasing by 10 rev · min⁻¹ every 2 min (CADENCE). All tests involved exercise to volitional exhaustion. Heart rate was continually monitored (Polar favour). Fingertip capillary blood samples for blood lactate analysis (BLa; Analox GM7) were collected at rest and volitional exhaustion. Local (working muscles) and central (cardiorespiratory) perceptions of effort (RPE; Borg Scale) were recorded during each stage. Expired gas was analysed for peak oxygen uptake ($\dot{V}O_2$ peak) via an online breath by breath analysis system (Metamax 3b). Differences in exercise test duration and peak responses were analysed by paired *t* tests.

Time to exhaustion was shorter ($P=0.037$, Effect size = 0.75) and blood lactate was higher ($P=0.029$, Effect size = 0.69) for CADENCE when compared to 70RPM (Table I). No differences were observed between other variables ($P > 0.05$, Effect sizes = 0.03–1.00).

The results of this study show that where individualised protocols can be prescribed, increasing cadence during incremental arm crank ergometry provides a valid assessment of $\dot{V}O_{2\text{ peak}}$ over a shorter test duration.

Table I. Peak responses to both exercise tests.

	70RPM	CADENCE
$\dot{V}O_2$ peak (L.min ⁻¹)	2.47 ± 0.51	2.48 ± 0.43
Heart rate (beat.min ⁻¹)	184 ± 7	183 ± 7
PMP (Watts)	137 ± 38	132 ± 37
RPE _{central}	18 ± 2	18 ± 2
RPE _{local}	20 ± 2	20 ± 2
BLa (mmol · L ⁻¹)	8.8 ± 1.9*	10.1 ± 1.8
Test time (s)	1075 ± 64*	1026 ± 45

Note: *Significantly different from CADENCE ($P < 0.05$).

SPHP1-27

Motion characteristics and heart rate responses during soccer training games

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Adaptation to training stimuli is dependent on a physiological overload being imposed. In team sports, training intensity has traditionally been tracked through heart rate monitoring. Whilst variations on small sided game scenarios have been widely reported to elicit competition-specific heart rates, little evidence exists to quantify the motion characteristics of such practices. The recent advent of Global Position System (GPS) technologies in a comfortable robust and portable format has enhanced the potential for monitoring and quantifying work rates in many “field-based” environments. The aim of this study was to investigate the effect of playing area on work rate and heart rate during small-sided soccer training games.

With ethical approval five academy-level players (mean 16.9, $s=0.5$ years) from an English Premier League soccer club participated in two trials of 24 min standardised 5v5 practices on three playing area dimensions (small (SP) 23 × 32 m, medium (MP) 27 × 37 m and large (LP) 32 × 41 m). Each session consisted of two bouts of 4 min each of non-directional, semi-directional and directional soccer play, with 2 min recovery between each bout. The drills are typical of those routinely performed in a professional soccer environment. Doppler shift 1 Hz GPS units (GPSports, Canberra, Australia) measured total distance covered (D), high-intensity distance covered (HID; $> 19.8 \text{ km} \cdot \text{h}^{-1}$) and heart rate (HR). All values were reported relative to individual average match values (% Ma). Why did you choose this format? It is not entirely clear how it was calculated.

D increased as playing area increased (SP = 92% Ma, MP = 96% Ma, LP = 109% Ma). HID also increased with increases in playing area (SP = 14% Ma, MP = 31% Ma, LP = 74% Ma). HR was lowest with SP trials (94% Ma) and was the same during MP and LP trials (99% Ma). Medium and large playing area dimensions elicited match-specific HR and D, whilst all playing area configurations elicited high intensity work rates which are much lower than those used during competitive match play.

GPS technologies provide a useful medium by which to quantify the work rate produced during team sports training drills. The motion characteristics

of small sided soccer games are specific to playing area size. Coaches should be mindful of the motion-based responses to training drills when selecting playing area dimensions. More research is needed to quantify the impact of variation in practice conditions on motion characteristics of team sports training drills.

SPSP1-27

Coping with coach stress

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In addition to athlete stress (e.g. Hanton *et al.*, 2005, *Journal of Sports Sciences*, 23, 1129–1141), recently, researchers have focussed their attention to the “coach performer” and their specific stressors (Frey, 2007: *The Sport Psychologist*, 21, 38–57; Thelwell *et al.*, in press: *Journal of Sports Sciences*). While such studies have suggested stressors range across performance (both athlete and coach related) and organisational domains, little is known about how coaches cope with stress. As such, the purpose of the present study was to ascertain the coping strategies typically engaged in by coaches to overcome stressors.

Eight elite level coaches (Mean age 33.4 $s = 6.9$) gave their consent to participate in the study. To be included in the study, coaches were required to have worked, or currently work with “elite” level athletes (cf. Hanton *et al.*, 2005: *Journal of Sports Sciences*, 23, 1129–1141). Having identified what coping means in relation to stressors, semi-structured interviews (lasting between 30–45 min) were employed to explore the methods of coping employed. In addition to the key question that referred to how they cope, probe and elaboration questions were used to clarify the narrative.

The coaches reported a range of methods to cope with stressors. A total of 95 raw data themes were placed into 18 first order themes and six general dimensions. The general dimensions were cognitive techniques (e.g. be rational, reflect on the successes), emotion-focused strategies (e.g. take out frustration, have a good moan), behavioural (e.g. go for a walk, eating), external support (e.g. use of specialists, use of coaches from other sports), reflection (e.g. past experiences, other coaches) and avoidance-coping (e.g. just forget about things, get away from the sport). Despite the wide ranging general dimensions, all participants reported the use of at least one strategy from within each dimension. This suggests that coping is a multidimensional response.

The findings suggest that elite level coaches employ a range of coping strategies to overcome stressors. On the assumption that practitioners will work with coaches to enhance coach performance, examining the strategies employed by those at the top of their profession appears beneficial. Unfortunately, this study merely examined the coping strategies employed; it is suggested that future studies consider how coping directly relates to the varying stressor types. It may also be necessary to examine sport-specific stress and coping, the effectiveness of coping strategies, and whether specific strategies are employed in training or competition environments.

SPHP1-28

The influence of work interval intensity and duration on time spent at a high percentage of $\dot{V}O_{2\max}$ during intermittent bouts of supramaximal exercise

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The purpose of this study was to examine the effect of manipulating work interval intensity and duration on the time spent at, or above, 95% $\dot{V}O_{2\max}$ during intermittent bouts of supramaximal exercise. Following institutional ethical approval, seven physically active men with a mean ($\pm s$) age, height, body mass and $\dot{V}O_{2\max}$ of 22 ± 5 years, 181.5 ± 5.6 cm, 86.4 ± 11.4 kg, and 51.5 ± 1.5 ml \cdot kg min^{-1} , respectively, attended seven testing sessions over a five-week period. Participants first completed a submaximal incremental test on a treadmill (7×3 min stages with $1 \text{ km} \cdot \text{h}^{-1}$ increments) to identify individual oxygen uptake/running velocity relationships. After 5 mins of passive recovery, participants completed a maximal incremental test to exhaustion to establish $\dot{V}O_{2\max}$, and subsequently (from the aforementioned relationship) the minimum velocity required to elicit $\dot{V}O_{2\max}$ ($v\dot{V}O_{2\max}$). In a random order, and separated by at least 48 h, participants then carried out three intermittent runs to exhaustion at both 105% $v\dot{V}O_{2\max}$ and 115% $v\dot{V}O_{2\max}$. Each test utilised a different work interval duration (20, 25 or 30 s) interspersed with fixed 20 s passive recovery periods.

A two-way repeated measures ANOVA revealed no significance in time spent at, or above, 95% $\dot{V}O_{2\max}$ for intermittent runs at 105% $v\dot{V}O_{2\max}$ compared to intermittent runs at 115% $v\dot{V}O_{2\max}$ ($F = 2.850$, $P = 0.142$). There was however, a significant effect ($F = 17.110$, $P < 0.001$) of work interval duration on time spent at, or above, 95% $\dot{V}O_{2\max}$; with work interval durations of 30 s enabling more time to be spent at, or above 95% $v\dot{V}O_{2\max}$ relative to work

interval durations of 20 s ($P=0.018$) and 25 s ($P=0.009$). Moreover, there was an interaction between exercise intensity and work interval duration such that the effect of work interval duration was magnified at the lower exercise intensity ($F=4.040$, $P=0.046$). In conclusion, despite a number of limitations, the results of this investigation suggest that exercise intensities of around 105% $\dot{V}O_{2\max}$ combined with work interval durations ≥ 25 s provide the optimal means of spending time at, or above, 95% $\dot{V}O_{2\max}$ when using fixed 20 s stationary rest periods.

SPSP1-28

Examining mental toughness among sports coaches

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With recent research advocating that coaches should be viewed as “performers” in their own right (e.g. Thelwell *et al.*, 2008: *The Sport Psychologist*, 22, 38–53) it could be suggested that to be successful, coaches need to be mentally tough. Following the research that has been conducted in mental toughness with elite athletes (e.g. Jones *et al.*, 2007: *The Sport Psychologist*, 21, 243–264), the purpose of the present study was to examine the attributes that are thought to be associated with mentally tough coaches.

Seven elite-level coaches (Mean age 36, $s=7$) from a variety of sports gave their consent to participate in the study. Having reviewed the previous conceptually driven mental toughness literature (e.g. Jones *et al.*, 2002: *Journal of Applied Sport Psychology*, 14, 205–218) an interview guide was produced. Semi-structured interviews (lasting between 30–50 minutes) were employed to explore attributes associated with mental toughness in coaches. Probe and elaboration questions were employed to provide further clarity to the narrative.

The coaches reported a range of attributes associated with mental toughness. A total of 88 raw data themes were arranged into 21 first-order themes and eight general dimensions. The general dimensions were: unshakable belief and confidence (e.g. know you can get the best out of athletes, have utmost confidence in athletes’ ability, have a tough character); accepting anxiety and pressures (e.g. dealing with poor performance, dealing with criticism); man-management (e.g. conflict resolution, maintaining respect); flexibility and adaptability (e.g. dealing with budgets, other coaches input/ideas); critical evaluation (e.g. accepting weaknesses, views

from others); desire and motivation (e.g. having constant energy and enthusiasm); decision making (e.g. able to make tough decisions), and emotional intelligence (e.g. able to regulate emotions). As with the athlete-focused research, the coaches cited issues relating to belief and confidence with the greatest frequency. All participants reported how the attributes may interact and it was apparent that some sport-specific attributes may exist.

The findings suggest that attributes associated with being a mentally tough coach are wide ranging. Further to this, it could be assumed that coaches view mental toughness as an important factor that enables them to perform well. As a result, future work may wish to explore coach toughness across a wider population, and in particular focus on the development of a conceptually driven definition of mental toughness for coaches and how coach toughness is developed and maintained.

SPHP1-29

Cardiorespiratory fitness and serum brain derived neurotrophic factor

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Evidence suggests that serum levels of the protein Brain Derived Neurotrophic Factor (BDNF) are a biomarker of the health of the nervous system, with lower concentrations found in neurodegenerative disease (White & Castellano, 2008: *Sports Medicine*, 38, 91–100). Short bursts of high intensity exercise transiently increase serum levels of BDNF from platelet stores (Tang *et al.*, 2008: *Neuroscience Letters*, 431, 62–65). However, the relationship between serum BDNF and long-term, regular exercise in humans is unknown. The purpose of this study was to examine serum BDNF in volunteers who varied in their long-term exercise to investigate the relationship between BDNF and cardiorespiratory fitness.

Nine men (age mean 25.3, $s=4.5$ years; height mean 1.74, $s=0.03$ m; body mass mean 76.7, $s=7.3$ kg) gave written consent to take part in the university ethics committee approved study. Participation in habitual exercise was recorded by questionnaire (Baecke *et al.*, 1982: *American Journal of Clinical Nutrition*, 36, 936–942) and volunteers’ exercise habits ranged from none (sedentary) to regular engagement in endurance sports. An estimate of cardiorespiratory fitness ($\dot{V}O_{2\max}$, L min⁻¹) was determined by the Åstrand-Rhyming cycle ergometer test. Five millilitres of venous blood were

obtained by venepuncture and serum concentrations of BDNF were measured using enzyme-linked immunosorbent assay (ELISA). Blood pressure was measured at rest (Dinamap ProV) and heart rate was monitored both at rest and throughout the Åstrand-Rhyming test. The correlation between serum BDNF concentration, body mass, resting BP and HR, estimated $\dot{V}O_{2\max}$ and work rate (W) was analysed using standard statistical software (SPSS 14).

There was a significant inverse relationship between serum BDNF and estimated $\dot{V}O_{2\max}$ ($r = -0.802$, $P = 0.009$) and serum BDNF and work rate ($r = -0.675$, $P = 0.046$). The results indicate that individuals with greater cardiorespiratory fitness possess lower concentrations of serum BDNF. This is an opposite finding to work in rodent models where increased amounts of exercise correlate with greater serum BDNF concentrations. The present findings could indicate that a different mechanism of long-term exercise related regulation of BDNF exists in humans, however, these preliminary findings should be treated with caution and await confirmation with a larger sample size.

SPSP1-29

Mental toughness as explained by elite flying kilometre skiers

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Mental toughness (MT) is now regarded as an essential psychological performance characteristic related to medal winning success (Jones *et al.*, 2007: *The Sports Psychologist*, 21, 243–264), Excellence in Elite Cricket (Bull *et al.*, 2005: *Journal of Applied Sport Psychology*, 17, 209–227), and Professional Football (Thelwell *et al.*, 2005: *Journal of Applied Sport Psychology*, 17, 326–332). However, remains a lack of MT research within high risk sports. The proposition that mental toughness is contextually driven in relation to the nature of the sporting discipline has only been explored by Fawcett (2005: In Morris *et al.*, *Psychology Promoting Health & Performance for Life: Proceedings of the ISSP 11th World Congress of Sport*). This study attempted to investigate if perceptions of mental toughness by Flying Kilometre (FK) skiers ($n = 7$) supported existing findings from elite athlete populations within low risk environments.

FK is the world's fastest ski race with athletes capable of recording speeds in excess of 250 kph/

155 mph. Seven FK skiers were purposively selected for the study (three females, four males; mean age = 31.14 years/ $SD = 5.5$; mean FK experience = 7.4 years/ $SD = 3.8$). Semi structured interview method was adopted for data collection and interpretative phenomenological analysis explored emergent themes.

Trustworthiness was satisfied by member checking, referential adequacy, thick description and peer-debriefing. Informed consent from participants was granted. Findings support many previously substantiated MT themes such as absolute self belief, self efficacy in task completion, full attention on task and the ability to block out internal/external distractions, positivity, self regulation of event arousal and anxiety and having emotional stability. Yet, additional themes emerged as athletes reported that avoidance of race day over-think was a MT factor, being patient in weather conditions, making correct decisions, dealing with ego and knowing oneself were resonant themes. A striking theme which emerged was that participants did not consider the event to be particularly "tough" but an event they really enjoyed. Other perceived MT aspects of the sport but not registered as substantive concepts were, dealing with the travelling environment, having to deal with injury which results in inactivity, and combating boredom in poor weather windows whilst on tour. The findings reinforce the contention that mental toughness may well contextually driven and highlight the need for a research of MT in high risk sports.

SPHP1-30

Agreement and time-series analysis of power output indices measured during cycling training and competition

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Mobile cycle ergometers allow the continuous measurement of a cyclist's power output during training and competition. Nevertheless, the inherent variability in power output when cycling makes it difficult to evaluate precisely an individual training session or interpret macrocycles in training over time. Such variability also means that the calculation of mean power output is rarely commensurate with the cyclist's physiological strain. A valid alternative may be the use of an exponentially-weighted averaging process to represent the

data as “normalised power” (Coggan, 2003: <http://www.midweekclub.ca/articles/coggan.pdf>). Therefore, we aimed to explore the agreement, and the sensitivity to detect periodic variations, between different methods of summarising power data during long-term monitoring of training and competition.

Following institutional ethics approval, a competitive road-race cyclist (age 21 years, maximal power output 390 W) provided written informed consent to participate. Power output was monitored using an SRM mobile ergometer during every training bout and competition for 216 days, with 40 occasional days of complete rest during this period. Average, normalised and critical power were calculated for each session. General agreement between power indices was explored using Bland-Altman methods. Using Bartlett’s Kolmogorov-Smirnov tests, data were explored for fluctuations over time which were statistically different from non-random “white noise”. All time-series datasets were then explored for underlying periodicities using spectral analysis with a Hamming data window of 5 days.

The mean absolute power output over the 216-day period was 164, $s = 28$ W compared to 187, $s = 34$ W for normalised power and 219, $s = 43$ W for critical power. All three summary measures of power differed significantly from each other in terms of these mean values ($P < 0.0005$). Disagreement worsened at the highest power outputs. Ratio limits of agreement for random error were 1.26 for average *versus* normalised power and 1.35 for average *versus* critical power. The three summary measures of power were all found to show non-random cyclical variation (Bartlett’s $d = 0.21$ – 0.23 , $P < 0.001$). For average and critical power, one distinct peak in the periodogram was found at a period of 3.5 days. Normalised power showed a 3.5-day cycle and an additional sub-harmonic cycle with a period of 7 days.

These data suggest that considerable systematic and random disagreement exists between power summary indices compared over a long-term period of training and competition. At least some of this disagreement could be due to the relative insensitivity of average power to reflect training macrocycles.

SPSP1-30

Identified sources and origins of mental toughness of elite athletes, elite coaches and adventure/explorers

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Until recently, research into developmental aspects of mental toughness (MT) has been neglected due to the need to firstly identify and gather research consensus to “what it actually is”, Connaughton *et al.* (2008: *Journal of Sports Sciences*, 26 (1), 83–95). This purpose of the study was to explore participant’s beliefs (Elite athletes, $n = 10$, Elite Coaches, $n = 10$ and Adventure/Explorers, $n = 10$), through semi structured interview and IPA, the origins and significant influences on the development of MT in childhood (< 11 years), Adolescence (11–16 years) and adulthood (> 17 years). Trustworthiness techniques were applied and satisfied within the project (member checking, referential adequacy, thick description etc).

Findings show that MT has its origins in early childhood (self belief, confidence, dealing with mistakes and setbacks) and is strongly influenced through parental socialisation and school experience. Both independence (single child status) and sibling rivalry within families are sources of mental toughness for youngster (self awareness, motivation, determination and commitment). Parents, (especially mothers) were strongly linked to MT, due to displaying a hard work ethic and establishing both moral and behavioural codes of conduct. Being able to handle setbacks/failure was largely initiated within school and dealt with by teachers and parents and participants reported that mental toughness was “learnt the hard way” in the early years of childhood and early to mid adolescence (11–14 years). Intense competitive personality dispositions were reported and a dislike of losing was a recurrent theme through childhood/adolescence. A wide variety of potential influences (siblings and peers, teachers, coaches, parents, role models, self influence, extended family) were reported to contribute to MT development throughout adolescence and beyond. As adulthood approached independence and maturity became much more influential and only significant other people of personal importance registered as potential sources of MT (coaches/mentors, fellow athletes, trusted friends). Participants acknowledged that in early MT development support systems are essential for providing safe learning environments for experiences to be most effectively managed. Effectively dealing with setbacks and learning from them to become stronger was crucial for MT development.

Overall, MT was viewed as being developed largely through socialisation practices and influential significant others who nurture the psychological development of the participants over a prolonged period of time. MT development in a short time period of time (specifically adulthood) was not reported.

SPHP1-31

Reverting type 2 diabetes mellitus by combining low-carbohydrate diet with high-intensity interval training: A case report

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Chronic hyperglycaemia is associated with insulin-resistance and type 2 diabetes mellitus (DM). *In vitro* studies on insulin-resistant cells have shown that insulin-sensitivity is restored when the glucose concentration in the medium is reduced to normal levels. The purpose of the study was to reduce high extracellular glucose levels (hyperglycaemia) and intracellular glucose availability (glycogen) *in vivo* in an overweight female by combining a low-carbohydrate diet (Low-CHO) and exercise-induced glycogen depletion in order to amplify the recovery of insulin-sensitivity.

Case Report: An untreated, overweight (BMI 32), sedentary 39 year old female with type 2 DM (fasting glucose 9.0 mmol/L, insulin 18.9 mU/L) underwent a 4 week Low-CHO diet (energy restriction to 75% of resting energy expenditure: 35% CHO, 15% proteins, 50% fats, 33% unsaturated) combined with high-intensity interval training (3/week, 10 bouts of 4 min 90% $\dot{V}O_{2peak}$, 3 min rest). When she first attended our laboratory, her average energy intake was 2144 kcal/day. Fasting and 2 hour plasma glucose levels during an oral glucose tolerance test (OGTT) were considerably high (9.0 mmol/L and 16.0 mmol/L) and so was the fasting insulin level (18.9 mU/L). Insulin-sensitivity index (ISI) was low (1.53) and plasma cholesterol, triglycerides, HDL and LDL were abnormal (6.06 mmol/L; 3.81 mmol/L; 0.87 mmol/L and 3.47 mmol/L, respectively). Her body composition was 44.5% fat and 52.6% lean mass (DEXA). $\dot{V}O_{2peak}$ on a cycle-ergometer was 21.6 mL·kg⁻¹·min⁻¹.

Post-intervention OGTT fasting glucose had reduced to 6.9 mmol/L and fasting insulin to 17.0 mU/L. ISI increased from 1.53 to 1.96. Fasting plasma cholesterol and triglycerides decreased from 6.06 to 5.67 mmol/L and from 3.81 to 2.24 mmol/L respectively. The intervention resulted in a 2.9 kg weight loss, while body fat decreased by 3.2 kg and lean body mass increased by 0.3 kg. $\dot{V}O_{2peak}$ increased by 6 mL·kg⁻¹·min⁻¹. Intramuscular glycogen levels (from a needle muscle biopsy of the vastus lateralis) declined in 2 weeks from 632 to 415 mmol glucosyl U/kg protein.

In this case report it has been shown that in an untreated female with type 2 DM, a simple, low cost intervention of low-CHO diet combined with high-intensity interval exercise to induced glycogen depletion can drastically reverse the main features of type 2 DM in 4 weeks.

SPSP1-31

Unexplained underperformance syndrome in professional darts – a psychological case study “U” turning a major performance slump

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Researchers have studied the psychological characteristics of champion athletes in an attempt to identify which personality characteristics are most influential in determining “what makes a champion” (Gould *et al.*, 2002: *Journal of Applied Sports Psychology*, 14, 172–204). Recently mental toughness has been identified as an important psychological factor that the world’s best performers are required to demonstrate in order to be champions (Jones *et al.*, 2007: *The Sports Psychologist*, 21, 243–264).

However, little research is dedicated to understanding how and why champion athletes experience catastrophic slumps in form. Given champions have the psychological mindsets required to win events, they sometimes “lose it” mentally and experience unexplainable form declination. Theoretical explanations for unexplained form declination are unexplained underperformance syndrome, (Budgett *et al.*, 2000: *British Journal of Sports Medicine*, 34, 67–68) or Athlete Burnout (Cresswell & Eklund, 2007: *The Sports Psychologist*, 21, 1–20), but this is more linked to highly intense physically demanding disciplines such as rowing, endurance cycling, tennis, swimming or rugby, unlike the discipline within this study (darts).

This case study followed the form of a 13 times world champion that lost their number one status (beaten in a World Championship final). The SP was approached to assist in “U Turning” underperformance following an intense 5 months period of poor form (no major tournament wins and a number of 1st round exits). A multi-method approach to psychological and behavioural performance analysis included prolonged engagement of in depth interviews, direct observation of exhibitions, training and competition events, video analysis of past performances and interviews with direct support system significant others (agent, family, training partners, friends).

As a result a phased Psychological Intervention Programme (PIP) was constructed which targeted an immediate “U Turn” of form within 4–6 weeks of initiation. The PIP included multi phased cognitive and behavioural interventions which operated both sequentially and simultaneously to accommodate the flexibility demanded by the changing nature of the athletes competitive schedule. The successful interventions required the athlete to address personal, environmental and organisational and lifestyle stressors. This PIP programme culminated in four major tournament victories within 8 weeks of initiation, which provided evidence that the cause of the form slump was psychologically driven.

SPHP1-32

Inspiratory muscle training improves intermittent running performance

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Improved cycling and rowing time-trial performances have been observed following inspiratory muscle training (IMT) (McConnell & Romer, 2004: *International Journal of Sports Medicine*, 25, 284–293). IMT accelerates recovery during high-intensity, intermittent shuttle running (Romer *et al.* 2002: *International Journal of Sports Medicine*, 23, 353–360), but whether it improves repeated, intense exercise performance remains unknown and was the focus of this study. We hypothesised that IMT would increase intermittent running performance in soccer players, as assessed by the distance covered during the Yo-Yo intermittent recovery (Yo-Yo IR1) test.

Following institutional ethics approval, 17 competitive male soccer players (mean $\dot{V}O_{2\max}$ 53.58, $s = 5.88 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) were assigned to either a pressure-threshold IMT group ($n = 9$) or a sham dietary supplement placebo group ($n = 8$). Prior to and following a 4 week intervention, participants completed the Yo-Yo IR1 test. IMT comprised 30 dynamic inspiratory efforts twice daily at an intensity of 50% maximal inspiratory mouth pressure (MIP). The placebo group ingested one glucose-filled capsule daily believing it to contain a multivitamin that promoted increased red blood cell production.

MIP increased following IMT (mean 116, $s = 19$, *versus* mean 142, $s = 22 \text{ cm H}_2\text{O}$, $P < 0.001$), and was unchanged following placebo (mean 114, $s = 22$, *versus* mean 120, $s = 12 \text{ cm H}_2\text{O}$). Distance covered during the Yo-Yo test increased following IMT (mean 1804, $s = 513$, *versus* mean 2133, $s = 478 \text{ m}$, $P = 0.01$) and was unchanged following placebo (mean 2250, $s = 442$, *versus* mean 2315, $s = 657 \text{ m}$);

however, a group \times time interaction was not observed ($P = 0.11$). Blood lactate concentration was lower following IMT during the initial 1080m (mean 3.95, $s = 1.15$ *versus* mean 2.95, $s = 0.94 \text{ mmol} \cdot \text{l}^{-1}$, $P = 0.02$) and upon completion of the Yo-Yo test (mean 8.68, $s = 1.31$ *versus* mean 6.96, $s = 1.43 \text{ mmol} \cdot \text{l}^{-1}$, $P < 0.001$), but was unchanged following placebo. Rating of respiratory exertion (measured using Borg’s modified CR10 scale) was lower during the initial 1320m following IMT (mean 5.8, $s = 1.6$ *versus* mean 4.6, $s = 1.3$, $P = 0.003$) and placebo (mean 4.5, $s = 1.4$ *versus* mean 3.8, $s = 1.1$, $P = 0.048$). No group \times time interaction effects were observed for these variables.

In conclusion, IMT may improve soccer players’ capacity to perform high-intensity intermittent exercise. The causative mechanisms remain unclear, but may be related to metabolic changes associated with muscle fatigue, which accelerate recovery and improve exercise tolerance.

SPSP1-32

Exploring the concept of collective toughness/resilience within interactive squads

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The concept of mental toughness (MT) from an individual perspective has been explored by numerous researchers and general consensus has been achieved as to how people explain the concept and what constitutes being a mentally tough athlete (Jones *et al.*, 2002: *Journal of Applied Sports Psychology*, 14, 21–224; Connaughton *et al.*, 2008: *Journal of Sports Sciences*, 26(1), 83–95). However, research has yet to address the concept of collective toughness/resilience within team sports. Mental Toughness research using team sport samples such as Elite Cricket (Bull *et al.*, 2005: *Journal of Applied Sport Psychology*, 17, 209–227), and Professional Football (Thelwell *et al.*, 2005: *Journal of Applied Sport Psychology*, 17, 326–332) did report findings related to the concept of collective toughness and as a result the concept of collective toughness/resilience within team sports remains unexplored.

The study attempted to explore the concept of collective toughness/resilience within a number of interactive squads ($n = 10$) from a range of sporting disciplines (football, rugby, hockey, basketball, netball, rowing). Squads were conveniently selected from a collection of elite/sub elite interactive squads. A focus group method was employed to determine the emergent conceptualisation of collective toughness/resilience themes. All sessions were audio

recorded, transcribed verbatim and selectively member checked for accuracy to ensure trustworthiness.

Substantive themes to emerge were collective efficacy and squad belief (when under pressure or facing adversity), Squad members commitment to team values, collective responsibility in goal achievement and goal commitment, protection for others in the team, team discipline in response to opposition and officials, positive responses to difficulty, team focus and ability to avoid distraction, having a hard work ethic within the squad, open communication and co-operation, trust for others, strong leadership, handling setbacks effectively (dealing with failure) and balancing success, role clarity and organisation, high levels of fitness and conditioning to perform under fatigue, having squad depth, being patient (strategically) and knowing how to win (winning mentality).

The emergent themes have some overlap with existing MT findings as individual components emerge as team issues, but there are group dynamics issues which require attention if collective toughness is to be fully achieved in sporting teams. The findings provide a foundation of psychological and group dynamic components for coaches and managers to consider when developing squad resilience and collective toughness within interactive teams.

SPHP1-33

Effect of a carbohydrate mouthwash on skill performance in male hockey players

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Carbohydrate mouthwash has been found to improve cycling time trial performance by 2.9% (Carter *et al.*, 2004: *Medicine and Science in Sports and Exercise*, 36, 2107–2111). However, an investigation into the effect of carbohydrate mouthwash on skill performance has never been conducted. Therefore, this study examined the effects of a carbohydrate mouthwash on field hockey skill performance.

Seven male university first team field hockey players (age mean 21, $s=2$ years; height mean 183, $s=5$ cm; mass mean 83, $s=7$ kg; $\dot{V}O_{2\max}$ mean 57.6, $s=3.2$ ml \cdot kg⁻¹ \cdot min⁻¹) volunteered to participate and gave their informed consent. Institutional ethical approval was obtained. Participants performed an intermittent treadmill protocol (on a motorised treadmill) designed to reflect the intensity of hockey match play. This involved two “halves” of 25 min separated by a 10 min rest period (half time) including varying speeds of 0, 6, 7, 20 km/h and speeds equating to 75 and 95% $\dot{V}O_{2\max}$. Prior to and immediately after (~ 5 min) the intermittent run-

ning, an electronic, computer recorded, hockey specific skill test (assessing accuracy and decision making) was performed. The protocol was carried out on two occasions separated by a 7 days interval during which a carbohydrate (CHO) mouthwash (6% maltodextrin and 3% fruit cordial) or placebo (PLA) mouthwash (3% fruit cordial) were administered in a double blind design. Heart rate, blood glucose and lactate, rating of perceived exertion (RPE) and oxygen consumption ($\dot{V}O_2$) were measured at intervals throughout the treadmill protocol.

Skill performance improved in five out of seven participants following the rinsing of CHO compared to the PLA trial represented by a decrease in the total time to complete the skill test (CHO mean 95.14, $s=13.82$ s; PLA mean 105, $s=11.80$ s). Following CHO rinsing, decision making time improved, decreasing in six out of seven participants compared to the PLA trial (CHO mean 4.31, $s=0.43$ s; PLA mean 5.32, $s=1.56$ s). However, these improvements were not significant ($P=0.119$, $P=0.185$ respectively). There was a significant decrease in heart rate between the two halves of the treadmill protocol in the CHO trial (mean first half 155, $s=9$ beats \cdot min⁻¹, mean second half 154, $s=6$ beats \cdot min⁻¹ respectively; $P=0.007$). There were no significant differences in blood glucose and lactate, RPE and $\dot{V}O_2$ throughout the protocol.

In conclusion, there appeared to be a positive effect on skill performance, although not statistically significant, the reasoning behind which warrants further investigation.

SPSP1-33

Psychological and emotional responses of professional football players within phase(3) injury rehabilitation – (return to competition)

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The varied emotional responses to injury rehabilitation have been reported from immediate onset to 3 weeks post injury by Tracey (2003: *Journal of Applied Sports Psychology*, 15, 279–293). However, an interesting psychological and emotional phase of injury is experienced immediately prior to the return to competition (final phase injury), following surgery/rehabilitation.

The purpose of this study was to investigate psychological and emotional responses during final phase rehabilitation following serious athletic injury. Face-to-face semi-structured interviews were conducted with six purposively chosen male professional footballers (Mean age = 27 years, SD = 4.87), all

who were within 2 weeks of a return to competition, following at least 4 weeks absence due to injury (knee, ankle or lower back). Following informed consent in line with university ethical research guidelines, semi structured interviews were conducted. Trustworthiness techniques included referential adequacy, thick description and peer de-briefing in accordance with Lincoln and Guba (1985: *Naturalistic inquiry*, Newbury Park, CA: Sage).

A number of salient themes emerged within six major categories pertaining to the emotional responses during final phase rehabilitation including (1) Living without Football (loss of sense of belonging, frustration and envy); (2) Returning to Football (re-injury, self-doubt, low confidence and mental toughness); (3) Mental Strategies/Coping (self-motivation, self-reliance and social support); (4) The Decision Making Process (empowered unto self, sense of unjust); (5) Past *versus* Present Emotion (pessimism replaced by renewed optimism, relief and happiness), and (6) Future Transition (concern for match fitness and increased desire). The psychological and emotional responses 1 and 2 were specifically related to old self-present self perception; factor 3 was related to present self perception; factors 4 and 5 related to present to new self perception and future transition was entirely related to future self.

Findings support Tracey (2003: *Journal of Applied Sports Psychology*, 15, 279–293), in that more seriously injured athletes (ACL) reported more negative emotions in the final phase compared to less serious injured athletes and the return to football was accompanied by both positive and negative emotions (sense of accomplishment, a fear of re-injury, self doubt, excitement, increased self determination, mental resilience and a concern for match fitness).

The emotional responses reported by the six participants provided unique profiles which varied considerably, and this suggests an idiographic approach may be best suited to understanding emotional responses to athletic injury.

SPHP1-34

Recovery of rowing sprint performance after high intensity strength training

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There is minimal research on recovery of sports specific functional performance after multi-joint high

intensity strength training. The aim of this study was to establish the time course of recovery of rowing sprint performance and muscle function following a high intensity strength training session.

With institutional approval, ten club rowers (mean \pm s, 20.4 \pm 2.8 y, 86.7 \pm 9.9 kg, 192.8 \pm 6.2 cm) with Olympic lifting and conventional resistance training experience participated in a repeated measures study. Participants performed baseline measures of 4 separate counter-movement jumps (CMJ) and a 250 m rowing ergometer sprint (stroke rate fixed at 30 spm). Twenty-four hours after baseline, participants performed a high intensity strength training (ST) session (3–4 sets \times 5–8 reps @ 75–85% 1RM for snatch, clean, back squat, romanian deadlift, bench press, bent over row and 3 sets \times 15 reps with 10 kg weighted sit-ups). Rowing sprint tests and jumps were repeated 24, 48 and 72-h post ST. Ear-lobe capillary samples for determination of creatine kinase (CK) and lactate dehydrogenase (LDH) were assessed pre ST and 1, 24, 48 and 72-h post. A visual analogue scale (VAS) for soreness rating (0–10) was also measured (Avery *et al.*, 2003: *Journal of Strength and Conditioning*, 17, 801–809).

Rowing performance decreased significantly 24-h post ST compared to baseline (44.1 s *versus* 44.6 s; $P=0.01$, $\eta^2=0.001$) but returned to pre-test values at 48-h. There were no significant changes in CMJ. Soreness rating was significantly greater at 1 h (VAS=4.9, $P=0.001$), 24 h (VAS=5.6, $P=0.001$) and 48 h (VAS=4.1, $P=0.006$) compared to baseline (VAS=0.7). Creatine kinase significantly increased from 245 \pm 192 U/L at baseline to 513 \pm 311 U/L at 24 h ($P=0.02$); but returned to baseline after 48 h. There was a non-significant change in LDH at any time point.

High intensity strength training produced a significant decrease in sports specific functional performance 24-h post ST. A period of 48-h was sufficient for recovery of specific muscle function and CK to baseline. These findings provide valuable information regarding recovery of athletic performance and muscle function following high intensity strength training and could assist in achieving optimal scheduling of training.

SPSP1-34

Home advantage and set outcome in high-level volleyball

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The advantage of the team that plays at home is a phenomenon of high scientific interest (Balmer *et al.*, 2007: *Journal of Sport Behavior*, 30(2), 130–145). Being familiar with the local conditions, having social support, not having to travel and adjust to time changes are factors that increases the environmental control and reduces the negative effects of stress (Pearlin *et al.*, 1981: *Journal of Health & Social Behavior*, 22(4), 337–356). Due to this, these are possible justifications for the superior performance of home teams. Despite the popularity and widespread of home advantage research, the game of Volleyball is still scarcely studied. In fact, no research is available in the literature that even confirms this effect in high-level games. Therefore, the aim of this study was to identify home advantage in Volleyball games and to identify discriminating game-performance variables according to set location (home *versus* away) and set outcome (winners *versus* losers).

Archival data were obtained from 275 sets in the 2005 Men's Senior World League. The game-performance variables included attack, block, serve, set, dig and reception's coefficients (Coleman, Neville, & Gordon, 1969: *International Volleyball Review*, 17, 72–73). Game home advantage was 61.1%. From this sample, 158 (57.5%) sets were won by the home team and 117 (42.6%) sets were won by the away team. From a descriptive discriminant analysis, two statistical significant functions were obtained. The first function (Qui-square_{1,18} = 502.0, $P < 0.01$) accounted for 67.1% of the variance. The structural coefficients revealed strong emphasis on reception (0.66), attack (0.60) and serve (0.30) performances, which were clearly dominated by teams who win sets at home. The second function (Qui-square_{1,10} = 181.5, $P < 0.01$) accounted for 32.5% of the variance. The structural coefficients revealed strong emphasis on reception (–0.70) and attack (0.54), which seem characteristic from teams who lose sets away. Cross-validation results from the obtained model were 58.5%.

Perception of social support by the home teams, since contribute to the reduction of the negative effects of stress (Pearlin *et al.*, 1981: *Journal of Health & Social Behavior*, 22(4), 337–356) and anxiety level (Zimet *et al.*, 1988: *Journal of Personality Assessment*, 52(1), 30–41), can explain the higher performance of home teams. These results can provide initial evidence to support a specific approach when preparing for home and away games.

Acknowledgement

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SPSP1-36

Anxiety, attentional control and the quiet eye period in basketball free-throw shooting

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The aim of this study was to test the predictions of attentional control theory (ACT) (Eysenck, *et al.*, 2007: *Emotion*, 7, 336–353) in a sport setting. Eysenck *et al.* postulate that anxiety reduces attentional control by impairing the goal directed attentional system, causing reduced efficiency of inhibitory control. An objective measure of attentional control used previously in the sporting literature is the quiet eye period (QEP); the final fixation on a target prior to movement being initiated (Vickers, 1996: *Journal of Experimental Psychology: Human Perception and Performance*, 2, 324–354.) Previous research (see Vickers, 2007: *Perception, cognition and decision training: The quiet eye in action*. Champaign, IL: Human Kinetics) has demonstrated that longer QEPs are indicative of superior attentional control and subsequent performance. It was therefore hypothesised that QEPs would be shorter (and hence less effective) when participants were anxious and that this may result in poorer free-throw performance.

With institutional ethics approval, 10 university basketball players (mean age 20.3, $s = 0.90$) performed free-throws in two counterbalanced conditions designed to manipulate the level of anxiety experienced. Participants threw free-throws in each condition until they scored 10 hits and 10 misses, and performance was assessed in terms of free throw percentage accuracy. Cognitive state anxiety was measured immediately prior to each condition using the cognitive scale of the Mental Readiness Form-Likert (MRF-L; Krane, 1994: *The Sport Psychologist*, 8, 189–202). Participants wore an ASL Mobile Eye Tracker throughout and the QEP was assessed using Quiet Eye Solutions software (University of Calgary).

Paired samples *t* tests were performed on each of the dependent variables (see Table I). Participants were more anxious ($t_9 = 5.17$, $P < 0.005$); performed worse ($t_9 = 5.52$, $P < 0.001$); and had shorter quiet eye periods ($t_9 = 3.61$, $P < 0.005$) in the high pressure condition.

Table I. Performance, state anxiety and quiet eye periods for low and high pressure conditions (mean \pm s).

	Performance (%)	State anxiety	Quiet eye period (ms)
Low pressure	68.60 \pm 11.02	3.29 \pm 1.24	512.65 \pm 250.93
High pressure	50.50 \pm 9.26	5.07 \pm 0.90	338.10 \pm 160.67

The results suggest that the QEP is sensitive to the effects of anxiety and is indicative of attentional control in aiming tasks. As predicted by ACT, anxiety-impaired attentional control, as participants were not able to maintain longer QEPs when anxious.

SPSP1-37

Team sport athletes' perception of cohesion and imagery use

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Cohesion of a team in a sport and exercise setting is a dynamic process that is reflected in the tendency for the particular team to stick together and remain united in the pursuit of its objectives (Carron, Brawley, & Widmeyer, 1998: Measurement of cohesion in sport groups, In *Advancement in sport and exercise psychology measurement* edited by J. L. Duda. Morgantown: WV: Fitness information technology). The relationship between athlete's perception of team cohesion and self-reports of behaviours as well as actual behaviour have been found in sport settings and research have suggested that imagery which plays a dual cognitive and motivational functions operating at either specific or general level is also often practiced in a team context and have proved to be effective for the performance success of a team (Hardy, Hall, & Carron, 2003: *International Journal of Sport Psychology*, 34, 151–167). This study investigated team sport athletes' perception of team cohesion and imagery use in sport.

Following approval from team officials and informed consent from 45 male elite athletes (age mean = 22.5; $s = 1.32$) whose sports consist of volleyball, basketball and football, the sport imagery questionnaire which measures athletes five imagery functions of cognitive specific, cognitive general, motivational specific, motivation general mastery and motivation general arousal and rated on a 7-point Likert scale anchored at the extreme by "rarely" (1) and "often" (7), and the group environmental questionnaire which assess individual attraction to group task, individual attraction to group social, group integration task as well as group integration social with responses on a 9-point Likert scale anchored at the extreme by "strongly disagree" (1) and "strongly agreed" (9) were administered on the athletes.

Results of the correlation matrix showed significant relationship between cohesion subscale of Attraction to group social and motivational specific ($r = 0.412$), Attraction to group social and motivation general arousal ($r = 0.316$), and Attraction to group task and cognitive specific ($r = 0.326$). Further results also

revealed that there was no significant composite effect of the cohesion $F(5,44) = 1.63$; $P > 0.05$ on imagery, with the imagery functions as predictor variables. Also a shared variance of 2.9% was recorded for the cohesion and imagery variables. The findings suggest that some social and task indicators have moderate influence on the athletes use of imagery functions of motivational specific, cognitive specific, and motivation general arousal. This implied that team sport members could be united on both social and task attraction indicators in relation to imagery use. This finding also lend support to the fact that individual attraction to groups social and task indicators were expected to have stronger relationship with athletes' use of imagery than the group integration task and social level manifestation of team cohesion. Therefore, further studies that will examine imagery, cohesion and other social cognitive variables such as sport confidence and cognitive anxiety in team sport setting especially from the developing countries are warranted.

SPSP1-38

The impact of time pressure on expectancy effects in tennis

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In social situations, individuals actively search for information that allows them to predict the likely course and outcome of an interaction. In facilitating this aim, expectations help guide the way in which individuals interpret the actions of others and ultimately respond to that individual. Although expectancy effects have been addressed within sport (Buscombe *et al.*, 2006: *Journal of Sports Sciences*, 24, 1265–1272) little is currently known about the factors that moderate such effects. Theorists have proposed that judgements made under time pressure may be more susceptible to expectation effects (Kruglanski & Webster, 1996: *Psychological Review*, 103, 263–283). The present study therefore aimed to investigate the impact of time pressure on expectancy effects in sport.

Following ethical approval from the second author's institution, 43 male undergraduate students (Age mean 24.5, $s = 5.2$) of mixed ethnicity volunteered to take part in the study. The participants reported having prior experience of tennis in both a spectating and playing capacity. The participants viewed video footage (3 mins 15 s) of a tennis player performing warm-up exercises followed by a period of play. During the warm-up the player displayed either positive or negative body language. The playing

footage was identical for all of the participants. The participants were further allocated to a time pressure (judgements of the performer completed before the end of the footage) or no time pressure condition (no stipulated time within which to respond). Participants indicated their judgments of the quality of the target performer's play on ten 9-point Likert scales.

Analysis of variance revealed a significant interaction effect, $F(1, 43) = 4.608$, $P = 0.038$, effect size $\eta^2 = 0.11$ and main effect for body language, $F(1, 43) = 4.415$, $P = 0.042$, effect size $\eta^2 = 0.10$. Follow-up t tests indicated that in the time pressure condition the participants reported more favourable ratings of the target's play when the player was viewed displaying positive body language as opposed to negative body language. There were no further significant differences evident between the groups.

When placed under time pressure the participants' ratings of the target player's performance were influenced by their early judgements and expectations of that performer. The findings carry significant implications for officials, coaches, and athletes with regards to the role expectations play in influencing judgements of performance. Future research should seek to further elucidate those factors that may serve to moderate this effect.

SPSP1-39

Does video modelling improve disabled swimmers' technique?

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Video modelling is an effective non-physical training method in improving athletic performance (Hodges & Williams, 2007: *Journal of Sports Sciences*, 25, 495–496). However, information regarding its impact on disabled athletes' performance is lacking. With particular reference to disability swimming, where time devoted to physical training is officially restricted based on the swimmer's disability classification, the impact of non-physical training methods such as video modelling could be crucial. Therefore, the aim of this study was to examine the effect of video modelling on disabled swimmers' performance.

After obtaining both institutional ethical approval and the participant's informed consent, nine national level competitive swimmers (age: mean 16.9, $s = 3.4$ years), with a range of disability classifications (S6–S14), underwent a 4-week video modelling intervention. A video showing Olympic disabled swimmers

performing backstroke was used. Performance (backstroke technique) was assessed at five testing points: pre- (PRE), mid- (MID) and post- (POST) intervention and, for retention purposes, two (R1) and four (R2) weeks after POST. Participants trained twice weekly; one session involved physical training only and the other combined both physical training and video modelling. Participant's backstroke technique was rated on seven elements (body position, leg action, arm action, start, finish, turn, and breathing) at each testing point by two expert coaches, using a scale from 1 ("poor") to 5 ("excellent"). Scores ranged from 17 to 33.5 points (out of a possible 6 to 35). Intra-class correlations between the two coaches were significantly high for all testing points (range from 0.75 to 0.97; $P < 0.05$). Thus, average scores were used for subsequent analysis.

Friedman's test showed a significant difference between testing points (Friedman $\chi^2 = 25.5$, $P < 0.001$). Wilcoxon matched-pairs test with Bonferroni adjustment ($P \leq 0.005$) showed technique improvement throughout the intervention from PRE (mean 21.2, $s = 2.4$) to MID (mean 22.8, $s = 2.7$) and POST (mean 25.3, $s = 4.7$). This improved technique was maintained from POST to both R1 (mean 25.4, $s = 4.6$) and R2 (mean 26.6, $s = 2.1$). No statistically significant differences were observed between R1 and R2.

The video modelling intervention had a positive effect on disabled swimmer's technique, both at implementation and retention phases. Given the physical training time restrictions in disability swimming, video modelling could have a substantial impact on improving swimming times. For an optimal implementation of video modelling, future research should consider, specifically, each disability classification.

SPSP1-40

The use of cognitive dissociation technique as a form of intervention to eliminate chronic cognitive anxiety in elite triathlon performance: A case study

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The inhibiting or debilitating effect of performance anxiety and its interpretation on performance is now well documented (Jones & Hanton, 2001: *Journal of Sports Sciences*, 19, 385–395). Whilst performing in endurance events such as triathlon, performance anxiety is open to temporal duration fluctuation. How the athlete interprets different internal states, matching appropriate psychological interventions with

personal preferences, together with the athletes ability to physically and mentally self regulate is the key.

This case study included in depth interview and psychometric assessment adapted competitive state anxiety inventory (CSAI 2), and access to training/log diaries. Pre-race retrospective diagnosis revealed high intensity (30/36) cognitive anxiety, and moderate somatic anxiety (24/36). The athlete interpreted the anxiety directional dimension as performance inhibiting. In depth interviews revealed that specific cognitive/somatic items intensified during the performance, particularly during the final phase running event. Such intensity resulted in repeated chronic physical discomfort (vomiting) despite careful nutritional preparation. The cause of such physical responses were attributed to extremely high cognitive anxiety levels escalating during performance linked into the fear of failure, expectations, apprehension and worry of a embarrassment in front of other competitors and supporters.

A four-phase intervention programme was initiated and this consisted of transition from clinic, human performance lab (treadmill), training and finally competition environment. A variety of dissociation exercises were designed to divert attention focus from problematic negative stimuli which were creating high cognitive anxiety. Techniques included internal and external imagery exercises, mind mapping, and numerical and alphabetical mental puzzles. Such strategies were developed in consultation with the athlete and meaningful stimuli were used in development of the interventions. Trial and error during practice sessions refined the design of the most effective strategies. During phase 2 (lab time) techniques were tested during treadmill performance before transition to training runs and finally competition. 4–6 weeks of practice enabled competitive races to be attempted. Results were encouraging and successful; following two races with process orientation and not outcome, the athlete registered a first place in a NW England Regional Triathlon. The successful intervention provides evidence that cognitive anxiety which has a direct effect on intensifying physical symptoms may be significantly reduced with dissociation strategies if mentally trained and developed by athletes over a 6-week programme.

SPSP1-41

The effect of music and feedback on running performance

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This study assessed the independent and combined effect of music and feedback on running performance, and the perceptual and affective responses to running. A repeated measures experimental design was employed, with 13 active male and female participants (Age mean = 23.53, $s = 4.53$) performing a 2-mile run on a treadmill under 4 different conditions: music only (MO), feedback only (FO), music and feedback (MF) and a control condition (C) with no music or feedback. Runners provided their own music and were instructed to run at their preferred pace. Feedback, provided using the Nike+[®] iPod system, consisted of time, distance and current running pace. In the feedback conditions participants could access this information as often as they desired, although automatic feedback regarding distance was given at half-mile intervals, and a 400 m count down to the end of the run was also provided. At regular intervals during the run participants rated their current perceived exertion (RPE) (Borg, 1998: *Borg's perceived exertion and pain scales*. Champaign, IL: Human Kinetics), feeling state (FS) (Hardy & Rejeski, 1989: *Journal of Sport & Exercise Psychology*, 11, 304–317), and felt-arousal (FAS) (Svebak & Murgatroyd, 1985: *Journal of Personality and Social Psychology*, 48, 107–116). Immediately after the run the participants also rated their perceived enjoyment of the run and the perceived usefulness of the run for their training purposes. Finally, FAS and FS were also assessed 10 min post-run.

Results of separate repeated measures ANOVAs indicated significant ($P < 0.05$) main effects for RPE, FS and FAS, and significant interaction effects for RPE by condition, FS by condition, and FAS by condition. Furthermore, there was a significant effect of music and feedback on the perceived enjoyment and perceived usefulness of the run. Specifically, the no-music control condition was perceived to be the least enjoyable and least useful run. The MF condition was the most enjoyable, while the MO and MF conditions were the most useful. There was no effect of condition on running performance, although there was a trend ($P = 0.06$) for faster running pace in the MO and MF conditions. There was also no effect of condition on post-run FS or FAS. These findings imply that listening to music and receiving performance feedback plays an important role in the perceptual and affective responses to running.

SPHP1-43

Prediction of racewalking performance via laboratory and field tests

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Table I. Regression equations.

Common racewalking economy	Field-laboratory	Performance-field
$\dot{V}O_2$ (ml · kg ⁻¹ · min ⁻¹) = 5.2482 treadmill speed (km · h ⁻¹) - 12.334 $r = 0.85^*$, $R^2 = 0.996$, $n = 68$	v-2 km (km · h ⁻¹) = 1.1042 v- $\dot{V}O_{2max}$ (km · h ⁻¹) - 1.4011 $r = 0.96^*$, $R^2 = 0.96$, $n = 21$	v-3 km (km · h ⁻¹) = 0.8624 v-2 km (km · h ⁻¹) + 1.6626 $r = 0.93$, $P = 0.002$, $R^2 = 0.76$, $n = 21$
Paired race distances (h:mm:ss)		
3-5 km	5-10 km	10-20 km
5 km = 1.4468 3 km + 0.0024 $r = 0.95^*$, $R^2 = 0.90$, $n = 31$	10 km = 2.0906 5 km - 0.0002 $r = 0.96^*$, $R^2 = 0.92$, $n = 44$	20 km = 2.1031 10 km - 0.0009 $r = 0.93^*$, $R^2 = 0.87$, $n = 44$
		20 km-50 km
		50 km = 2.8868 20 km - 0.0039 $r = 0.86^*$, $R^2 = 0.74$, $n = 63$

Note: * $P < 0.001$.

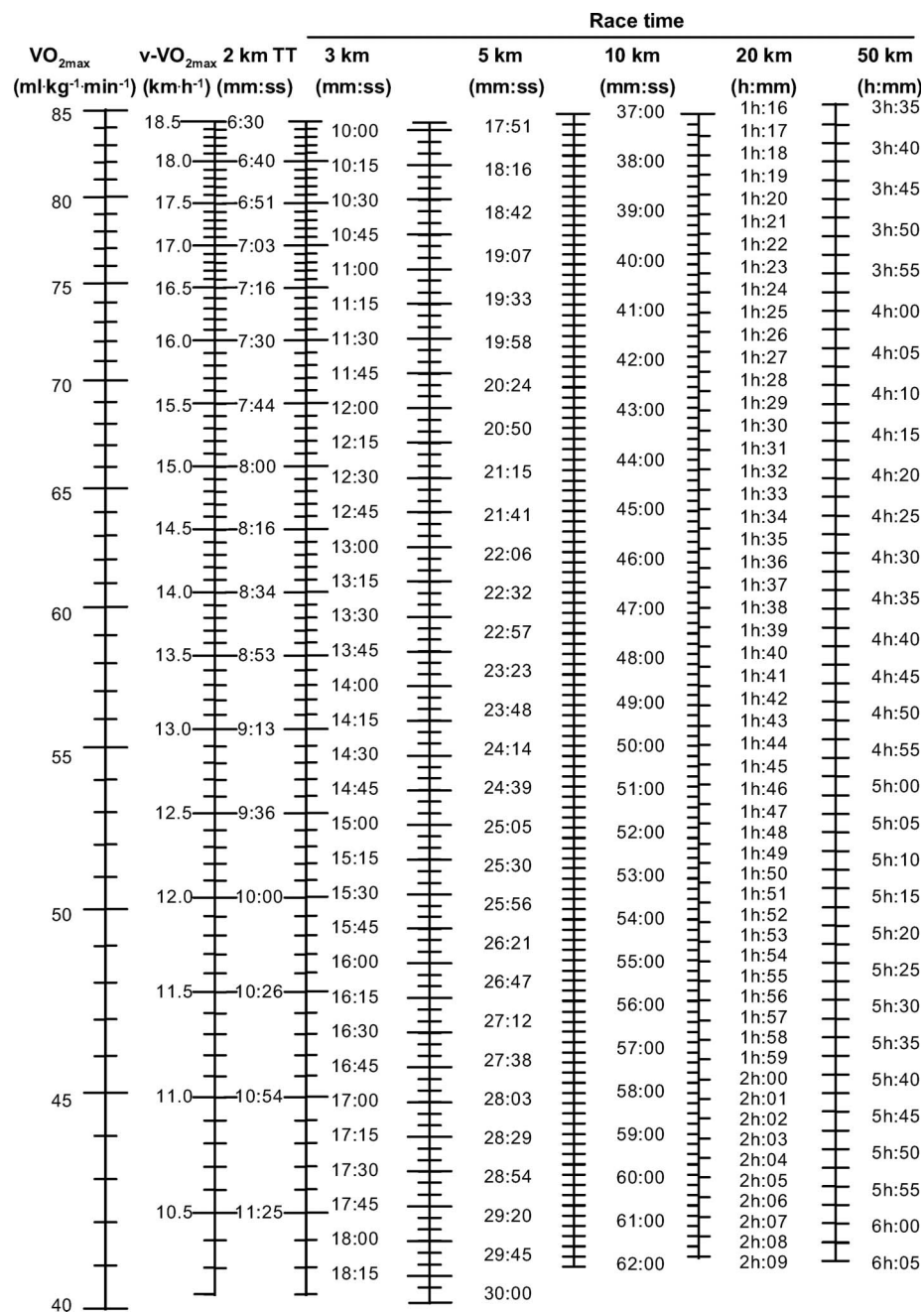


Figure 1. Racewalking nomogram (TT = time-trial).

Athletes compete in racewalking events of 3–10 km and the Olympic distances 20 and 50 km. A shorter field or laboratory test may predict performance and inform training. Therefore, this study investigated performance and physiological variable inter-relationships to enable construction of a nomogram for predicting performance.

Forty-five male and 23 female racewalkers volunteered for this study, which had University ethical approval. The mean age, height, body mass and maximum oxygen uptake were 27, $s=8$ years; 1.73, $s=0.08$ m; 64.3, $s=9.8$ kg; and 62.9, $s=11.3$ ml·kg⁻¹·min⁻¹. Participants completed a discontinuous incremental racewalking treadmill test to determine $\dot{V}O_{2\max}$ and velocity at $\dot{V}O_{2\max}$. Within 24 h of treadmill testing twenty-one athletes also walked an all out 2 km racewalking time-trial on a 400 m Mondo surface athletics track giving velocity at 2 km, which was compared to laboratory and race performances by the participants and linked to data comprising World and UK performance rankings during a 4 year cycle.

The regression relationships between variables (Table I, regression equations) were combined to construct a nomogram assuming common racewalking economy to predict physiological and performance variables from two or more known values (Figure 1, racewalking nomogram). $v-2$ km and $v-\dot{V}O_{2\max}$ were not statistically significantly different (paired samples t test, $P=0.213$).

The nomogram may be used for conditioning evaluation and identifying prerequisite performance levels. The 2 km time trial warrants validation with more participants to strengthen interrelationships between variables.

SOTP1-44

Effect of an 8-week supplementation with n-3 fatty acids on anxiety in competitive athletes

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Research suggests supplementation with essential fatty acids has significant psychological benefits. Several studies examined their effect on mood disorders and some examined their effects on stress. No previous studies have examined essential fatty acid supplementation in sport related anxiety. This study examines the effects of essential fatty acids on cognitive and somatic anxiety in sport.

Following ethical approval from the institution, and screening of volunteers, 24 participants (Male, $n=14$, Age mean 25.8, $s=9.3$ years; Female, $n=10$, Age mean 27.2, $s=7.1$ years) were recruited.

Participants completed a Food Frequency Questionnaire (FFQ) from Nutrition Systems, which was analysed by Comp-Eat dietary analysis software. Based on the participants baseline essential fatty acid intake participants were assigned to a control group ($n=12$) who took a placebo tablet for 8 weeks, or a fatty acid group ($n=12$) who took a fish oil supplement supplying 360 mg Eicosapentaenoic acid (EPA) and 240 mg Docosahexaenoic (DHA) per day in this double blind placebo controlled trial. BMI, blood pressure and heart rate were measured at weeks 0 and 8 with dietary intake, state and trait anxiety measured at weeks 0, 4 and 8. Trait Anxiety was measured using the Sport Competitive Anxiety Test (SCAT) developed by Martens, Vealey & Burton (1990: *Competitive Anxiety in Sport*. Champaign, IL: Human Kinetics Books). State Anxiety was measured using the Competitive State Anxiety Inventory (CSAI-2) also developed by Martens, Vealey & Burton (1990) which assessed two components of state anxiety, cognitive worry and somatic anxiety, and a related construct, self-confidence.

Unpaired t tests found no significant differences ($P>0.05$) in BMI, blood pressure or heart rate between weeks 0 and 8. Repeated measures ANOVA found no significant differences in any dietary variables examined apart from the significantly increased ($P<0.05$) $n-3$ and $n-6$ fatty acid intakes in the fatty acid group, as a result of dietary supplementation. Repeated measures ANOVA found no significant difference ($P>0.05$) between the control group and fatty acid group for SCAT, cognitive worry, somatic anxiety or self-confidence.

The possibility of a beneficial effect of fatty acids on anxiety still remains, since more research should be carried out within this area with higher numbers of participants, over a longer period of time, and at higher fatty acids doses.

SPSP1-45

Big wave surfing: Sensation seeking or rational assessment?

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Big wave surfing involves surfers being propelled into waves too big to paddle into. It is dangerous and one would have to ask, why would anyone push themselves such that life is endangered? Research into sensation seeking, compared action and non action sport participants' personalities, yet there is a deficiency in research involving the same action sport, at different

levels of extremity. This research investigates the difference in personality traits and motivation dimensions of high risk surfers *versus* low risk surfers.

Seventy surfers (male, $n=51$, Age mean 31.7 $s=9.4$ years; female, $n=19$, Age mean 28.4 $s=8.2$ years) from Ireland, England, Wales, America, Australia and New Zealand took part. High risk surfers ($n=23$) surfed waves > 10 feet high and low risk surfers ($n=47$) surfed waves < 10 feet high. Each participant completed the Zuckerman's sensation seeking scale V (SSSV) (Zuckerman, 1983: *Personality and Individual Differences*, 4(3), 285–292) which is made up of thrill and adventure seeking (TAS), experience seeking (ES), disinhibition (DIS) and boredom susceptibility (BS) components. Participants also completed the sports motivation scale (SMS) (Pelletier *et al.*, 1995: *Journal of Sport Exercise Psychology*, 17, 35–53) assessing seven forms of motivation: intrinsic motivation to know, intrinsic motivation accomplished, intrinsic motivation to experience stimulation, identified regulation, external regulation, introjected regulation and amotivation. Results found the majority ($n=36$) of participants surfed waves below 10 feet while a smaller number ($n=24$) surfed big waves. Mann Whitney U test found no significant difference ($P > 0.05$) in Sensation Seeking or motivation between big wave and regular surfers. Spearman's correlation found age was significantly negatively correlated to total sensation seeking ($P=0.001$) and total intrinsic motivation ($P=0.000$), total external motivation ($P=0.003$) and Amotivation ($P=0.002$). Spearman's correlation also found the more a participant surfed was significantly associated with greater intrinsic ($P=0.024$) and extrinsic motivation ($P=0.009$), with participants surfing longer having significantly lower levels of total internal motivation ($P=0.049$), total extrinsic motivation ($P=0.248$) and amotivation ($P=0.000$) plus disinhibition scores were lowest in participants surfing over ten years ($P=0.043$). These findings lend support to a difference in sensation seeking and motivation between surfers.

Further research, including qualitative research, into sensation seeking and motivation levels in other high risk sports should be considered.

SPSP1-46

Effects of confidence and mental effort on performance breakdown under pressure

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Research suggests that performance breakdown under pressure might be explained by the conscious

processing hypothesis (CPH) (Masters, 1992: *British Journal of Psychology*, 83, 343–358) in which re-investment of controlled processing at an autonomic stage of learning leads to skill breakdown. It has recently been suggested that a reduction in confidence can motivate an increase in effort (Vancouver *et al.*, 2001: *Journal of Applied Psychology*, 86, 605–620). The relationship between confidence, effort, and conscious processing has received little research attention. We hypothesised that reduced confidence would lead to increased effort, thus interfering with automatic processing and subsequent performance.

We used golf putting as the primary task and a secondary probe to measure changes in processing capacity. Following institutional ethical approval 66 participants were randomly assigned to novice and expert groups. Experts completed a skill acquisition phase (300 putts) to reach an autonomous stage of learning. Novices were inexperienced in putting and received 25 practice putts only, as did the experts prior to the test conditions. Both groups completed low and high pressure conditions, with a competition stress manipulation prior to the high pressure condition. In addition experts also received a negative confidence manipulation. We measured: self-confidence, cognitive and somatic anxiety, mental effort, primary task performance, and secondary task performance.

Single-factor ANOVA with repeated measures confirmed significant skill learning for the experts ($P < 0.001$). MANOVA confirmed significant increases in cognitive and somatic anxiety and a reduction in confidence prior to competition ($P < 0.001$). MANOVA revealed significant increases in mental effort invested ($P < 0.001$), but no significant change in counting accuracy. MANOVA also revealed a significant improvement in putting performance in the competition ($P < 0.05$), with experts consistently performing better across conditions ($P < 0.001$). This was further supported by a significant improvement in putting accuracy for experts which again was consistently higher than novices. Results support the hypothesised reduction in confidence and increase in effort but not the decrement in performance.

Findings do not support the CPH. However, they can be partially explained by processing efficiency theory (Eysenck & Calvo, 1992: *Cognition and Emotion*, 6, 409–434) and provide further support for the negative confidence-performance relationship (cf. Vancouver *et al.*, 2001: *Journal of Applied Psychology*, 86, 605–620). Future research should investigate determinants of positive and negative effects of anxiety-induced effort, and the negative confidence-performance relationship. Findings highlight that effects of confidence and

effort are not as straightforward as previously thought.

SPSP1-47

The lived experience of disordered eating in sport

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A growing research base implicates sport as a risk factor for eating disorders. It suggests that pressures to be thin for performance gains may trigger eating disorders in vulnerable individuals (Garner *et al.*, 1980: *Psychological Reports*, 47, 483–491). An abundance of studies have attempted to measure prevalence across various athlete categories, such as competitive level, gender and sport type. Most findings point to elite females participating in “lean” sports (e.g. gymnastics/figure skating) as being at an increased risk for eating disorder development (Smolak *et al.*, 2000: *International Journal of Eating Disorders*, 27, 267–275).

Critically, while assessment of potential risk factors is useful for understanding aetiology, it is less useful for understanding how athletes manage the disordered eating experience. Little is known of the impact disordered eating has on the life of an athlete. Further, current variable-centred correlation methods neglect both developmental insights and the personal accounts of sufferers. The purpose of this study therefore was to explore athletes’ experiences and the meanings they ascribe to them. It aims to illuminate the process of disordered eating over time through retrospective narratives.

After receiving University ethical clearance, a purposive, homogenous sample was recruited consisting of four individuals (Age mean 21.2, $s = 3.3$ years) with experiences of disordered eating in elite sport. Participants took part in an in-depth, semi-structured interview lasting between 90 and 120 min. These were transcribed verbatim and analysed according to the principles of interpretive phenomenological analysis outlined by Smith & Osborn (2003: In *Qualitative psychology: A practical guide to research methods*, edited by J. A. Smith. London: Sage). Five superordinate themes emerged from the data: (a) pressures of an elite environment; (b) the struggle to disclose; (c) social support needs; (d) obsessional thinking; (e) identity challenges.

Athletes described an often traumatic experience. Sporting pressures to be thin, previously identified in the “risk factor” research base, were ongoing and contributed to the maintenance of pathological

behaviours. An eagerness to receive social support was tempered by a reluctance to disclose information perceived as stigmatised. Athletes considered the persistent mental strain associated with an obsession and threats to their athletic identities as particularly stressful. This study provides a novel documentation of athletes’ perceived disordered eating experiences. An understanding of the emergent issues and challenges may assist practitioners in supporting athlete recovery.

SPSP1-48

Gender differences in the relationship between sensory-processing sensitivity and competitive anxiety

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High sensory-processing sensitivity is defined as a temperament characteristic caused by a nervous system that shows great sensitivity to both physical and psychological stimulation (Aron & Aron, 1997: *Journal of Personality and Social Psychology*, 73, 345–368). Aron and Aron’s (1997: *Journal of Personality and Social Psychology*, 73, 345–368) research suggests that the trait is equally distributed among males and females but that, at times, the consequences of high sensitivity may vary between the genders. The purpose of this study was to explore the role of gender in the relationship between sensitivity and competitive anxiety. Given the characteristics of high sensitivity, it was expected that its effect on anxiety would be similar for both genders.

With institutional ethical approval, 277 student athletes (57.4% Male, 42.6% Female; Age mean 19.2 years, $s = 1.6$), representing a range of sports and abilities, completed the Highly Sensitive Person Scale (HSPS; a 27-item uni-dimensional inventory; Aron & Aron, 1997: *Journal of Personality and Social Psychology*, 73, 345–368) and the trait version of the CSAI-2 (CTAI-2; Albrecht & Feltz, 1987: *Journal of Sport Psychology*, 9, 231–248). Pearson Correlations were calculated separately for each gender. Results showed significant relationships between sensitivity and both cognitive ($r = 0.375$, $P = 0.000$) and somatic ($r = 0.283$, $P = 0.000$) anxiety for males, but not for females. To further examine this difference, anxiety scores were compared among the highest and lowest scoring quartiles on the HSPS for both genders, using one-way MANOVAs. Significant overall effects were found for cognitive anxiety ($F_{3, 136} = 9.310$, $P = 0.000$, $\eta^2 = 0.17$) and somatic anxiety ($F_{3, 136} = 3.719$, $P = 0.013$, $\eta^2 = 0.08$). Scheffe post-hoc comparisons indicated no

significant differences in anxiety levels between low and high HSPS females. Among males, low HSPS had significantly lower levels of both cognitive ($P=0.000$) and somatic ($P=0.021$) anxiety than high HSPS, whose levels of anxiety were not significantly different from those of the females.

These results suggest that high levels of sensory-processing sensitivity are associated with higher levels of competitive anxiety for males but not for females. Males with high levels of sensitivity appeared similar in their anxiety levels to females, who tended to show higher levels of anxiety in general. Future research needs to examine the processes that mediate this relationship. On a practical level, sport psychologists working with male athletes should be mindful of the relationship between high sensory-processing sensitivity and anxiety.

SPSP1-49

Young female swimmers' and waterpolo players' sport competition anxiety and motivation

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In swimming and waterpolo, anxiety and motivation have major implications for adherence and for sport performances. The aim of our study was to investigate sports competition anxiety, intrinsic *versus* extrinsic motivation, and task *versus* ego orientation of young female performers using the self-determination and achievement goal theories, and establishing a link between the two theories (Ntoumanis, 2001: *Journal of Sports Sciences*, 19, 397–409).

The University of Sunderland Ethics Committee granted approval to our study. Twenty-four elite level female competitive swimmers ($n=12$) and waterpolo players ($n=12$) aged 13–15 years (mean age = 14.0, SD = 0.6) volunteered to participate. Data were collected using the Sport Motivation Scale (Pelletier *et al.*, 1995: *Journal of Sport & Exercise Psychology*, 17(1), 35–53), Task and Ego Orientation in Sport Questionnaire (Duda, 1989: *Journal of Sport & Exercise Psychology*, 11, 318–335) and the Sport Competition Anxiety Test (Martens *et al.*, 1990: *Competitive anxiety in sport*, 3–115, Champaign, IL: Human Kinetics Publishers).

Waterpolo players. Strong correlations were identified between self-determined motivation and task orientation ($r=0.56$) and with controlling motivation and

amotivation ($r=0.59$). Negative correlations were identified between amotivation and task orientation ($r=-0.46$), amotivation and self-determined motivation ($r=-0.42$) and self-determined motivation and controlling motivation ($r=-0.62$, $P<0.05$). Sport competition trait anxiety was associated with ego orientation ($r=0.44$) and controlling motivation ($r=0.49$). Amotivation was moderately associated with sport competition anxiety ($r=0.36$).

Swimmers. Highest correlations were found between amotivation and sport competition trait anxiety ($r=0.76$, $P<0.01$), and, surprisingly, between self-determined motivation and controlling motivation ($r=0.89$, $P<0.01$). Task orientation and self-determined motivation were also positively associated ($r=0.58$, $P<0.05$) as well as task orientation and controlling motivation ($r=0.63$, $P<0.05$).

In conclusion, swimmers showed higher amotivation levels than waterpolo players, albeit marginally ($t=2.007$, $P=0.057$). However, waterpolo players are more task-oriented than swimmers ($t=3.109$, $P=0.006$), and swimmers demonstrated a higher level sport competition anxiety ($t=2.864$, $P=0.010$). It is hypothesised that team sports, like waterpolo, provides greater opportunity for personal improvement. Also, in teams, players offer more personal support to each other and additionally may attribute success or failure to variables other than themselves, thus reducing personal anxieties. In contrast, swimmers competitive outcomes are individualised with, relatively speaking, nowhere to hide. Age and experiential level of the participants may also be an issue in terms of coping. In line with previous studies, findings suggests the adaptive role of task orientation in facilitating self-determined motivation in sport (Ntoumanis, 2001), which also contributes to anxiety reduction.

SPSP1-50

Assessing the factor structure and composition of the child and adolescent perfectionism scale in junior athletes

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While a number of psychometric measures have captured the effects of perfectionism for junior athletes, Hall (2006: In *Perspectives in sport and exercise psychology; essential processes for attaining peak performance*, edited by D. Hackfort & G. Tenenbaum. Oxford: Meyer & Meyer Publishers) recently encouraged sport and exercise psychologists to adopt the multidimensional definition of perfectionism

forwarded by Hewitt and Flett (1991: *Journal of Personality and Social Psychology*, 60, 456–470) because it avoids the conceptual ambiguity evident in other approaches. However, to date, only one published study has adopted this approach to perfectionism within junior athletes (Hill *et al.*, in press: *Psychology of Sport and Exercise*). To enable researchers the opportunity to employ this particular conceptualisation, the purpose of the current study was to validate Flett *et al.*'s (1997: unpublished manuscript) Child and Adolescent Perfectionism Scale (CAPS) within junior sport.

With institutional ethics approval, 249 junior athletes (Age mean 15.64, $s = 1.62$ years) completed the original 22-item CAPS, which measures self-oriented (SOP), and socially prescribed perfectionism (SPP). A confirmatory factor analysis using AMOS statistical software package indicated a poor fit to the proposed structure ($\chi^2 = (208 \text{ df}, N = 249) 730.331$ ($P < 0.01$) $\chi^2/\text{df} = 3.51$; SRMR = 0.11; IFI = 0.70, CFI = 0.70). Subsequent common factor analysis using principal axis factoring extraction (PAF) and oblique rotation (delta 0) supported the retention of two factors with six items each. This structure was cross-validated using a second sample of 189 junior sport participants (age mean = 14.73, $s = 1.45$ years) which supported a more parsimonious 12-item, two factor structure representing the SOP and SPP constructs ($\chi^2 = (53 \text{ df}, N = 189) 91.03$ ($P < 0.05$) $\chi^2/\text{df} = 1.72$; SRMR = 0.06; IFI = 0.93; CFI = 0.93). The two modified subscales were also internally consistent across both samples (α = SOP 0.75 & 0.70; SPP 0.84 & 0.80).

The results suggest the CAPS is represented by a 12-item, two factor model that clearly captures SOP and SPP in junior sport. The findings will enable sport and exercise psychologists to adopt a psychometrically validated measure of Hewitt and Flett's conceptualisation of perfectionism, and examine the processes that contribute to, and underpin the psychological effects of SOP and SPP in child and adolescent athletes.

SBIP2-03

The quantification of horse: Rider interaction by means of gyroscopes and accelerometers

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The speed of horse:rider interaction has been reported as an important indicator of riding skill.

Table I. The number of times the rider's force peak in the z axis came first, at the same time or after the horse's.

	Rider first	Same time	Horse first
Rider:Horse 1 trot	32	15	0
Rider:Horse 1 canter	11	7	13
Rider:Horse 2 trot	28	8	6
Rider:Horse 2 canter	9	3	19

Note: Chi-squared tests revealed all values to be significant ($P < 0.05$).

However to date visual observation of this interaction has been utilised in assessing skill, with no objective measures reported in the literature. Accelerations of the horse and rider were measured, in the orthogonal system, using an algorithm containing an accelerometer and gyroscope (Xsens), placed near to the horse's and the rider's centre of mass. We measured accelerations during walk, trot and canter in order to determine the timing of horse and rider accelerations in the orthogonal z axis.

Two elite riders rode a full lap at trotting and cantering speeds and their accelerations were measured at a sampling rate of 50 Hz. The Xsens measures acceleration and angles, with Quaternions the data were transferred to the global system. The signal in the global system was analysed in terms of timing difference.

Timing difference between the horse's and rider's signal. Timing in trot Rider 1(mean -0.0136 $s = 0.00942$ ms), Rider 2(mean -0.0102 $s = 0.01472$ ms) and in canter Rider 1(mean 0.0013 $s = 0.01784$ ms), Rider 2(mean 0.0065 $s = 0.01817$ ms). Similarities in the timing of gait cycle peak amplitudes in the rider compared to the horse were observed in the two elite riders as shown in Table I.

We observed a very small difference in timing in horse:rider interaction suggesting the rider is driving the horse. During trot both riders mainly peaked in their acceleration before the horse, but in canter it is distributed more equally.

The results prove to be promising, because of the similarity that is found in the pattern of the two elite riders. It would be interesting to look at lower skilled riders and compare them to the elite riders.

SBIP2-04

Squat assymetry: A case study

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Background. The squat is a resistance exercise that is assumed to be symmetrical (Flanagan & Salem, 2007: *Journal of Strength and Conditioning Research*, 21, 1220–1226). However, recent research (Flanagan & Salem, 2007: *Journal of Strength and Conditioning Research*, 21, 1220–1226) reported significant side dominances during squat performance. However the effect on barbell kinematics has not been considered. The aim of this case study was to investigate the influence that ground reaction force (GRF) asymmetries have on barbell kinematics during squat performance of a right side dominant subject.

Methods. Following University of Chichester ethical approval one male subject (BWLA unequipped 90 kg powerlifting champion), (age: 30, mass: 89.2 kg, height: 1.79 m, Squat 1 RM: 230 kg) participated in this case study. Three high-speed video cameras (Basler) and two force platforms (Kistler, 9851, Alton, UK) recorded barbell end displacements (100 Hz) and ground reaction forces (500 Hz) from both feet during the concentric phase of squat performance with loads of 30, 60 and 90% of the one repetition maximum (1 RM). Peak Motus 9 software was used to digitise barbell displacement; raw data were low pass filtered. Concentric phase barbell vertical displacement data (of both ends) and the vertical GRF (of both feet) were averaged and left and right values compared.

Results. Analysis of the average vertical GRF showed an initial left side dominance that shifted to the right side as the load increased to 60% 1 RM and back to the left side during the 90% 1 RM squat performance. The GRF differences between the dominant and non-dominant sides were 13.21, 6.71 and 56.65% respectively. The differences in the left and right side average barbell displacements during squat performance were 1.11% (left – 0.732/right – 0.740 m), 3.56% (left – 0.708/right – 0.733 m), 2.87% (left – 0.696/right – 0.715 m) for the 30, 60, and 90% 1 RM loads respectively with a consistent right side dominance.

Discussion. These results indicate that differences in GRF symmetry during progressive squat performance may not significantly influence barbell kinematics. In addition to this the results suggest that, contrary to the findings reported by Flanagan and Salem (2007) GRF asymmetries can increase as a consequence of increases in squat intensity.

SBIP2-05

The effect of a 6-week core stability training programme on rider position

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In dressage, it is taught that there should be a straight line from the rider's ear to the heel to ensure the rider's centre of gravity is over that of the horse for maximal balance and efficiency of the aids. Core stability is vital to maintain the stability of the thoracolumbar and pelvic regions when absorbing the energy from the horse and when applying independent hand and leg aids. The aim of the study was to explore whether a 6 week core stability training programme enabled the rider to maintain a position closer to the ideal.

Following institutional ethical approval 11 experienced female riders (mean age = 19.2, $s = 1.20$) whose sole form of exercise was riding were recruited. Rider position was analysed using 2D videography and OntrackTM measuring the deviation from the vertical of the orbitale, acromion process and the calcaneus. Riders rode the mechanical horse (Racewood Riding Simulator) in a dressage saddle for 3 min in the walk, slow trot and canter programmes increased with the middle minute being used for analysis. The riders undertook a supervised, progressive core stability training programme 4x per week for 6 weeks and then their position was re-evaluated.

Results showed that there was a significant decrease in total angular deviation using all anatomical points following the training programme (mean, -8.94° , $s = 8.7$, $t = 1.81$, $P < 0.01$). There was a significant decrease at the orbitale ($t = 1.81$, $p < 0.01$), and calcaneus ($t = 1.81$, $P = 0.036$) but not at the acromion process. There was a difference between pre-and post training position in walk ($t = 1.81$, $P < 0.01$), trot ($t = 1.81$, $P = 0.036$) but not in canter.

Lower leg and head position were positively affected by the core stability training programme suggesting that the pelvic and trunk areas were more effectively stabilised allowing more efficient energy absorption at the sacro-iliac joint. In canter there is a much greater and asymmetrical force from the horse suggesting that a longer training programme would be required to have an effect at canter.

Riders, coaches and support teams should be aware of the positive effects of core stability on rider position and athletes encouraged to undertake

dismounted core stability exercise to improve their ridden performance.

SBIP2-06

The effect of rider posture on the laterality of the equine trot

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In equestrian sport, the rider must maintain their own body position to allow the horse to optimise biomechanically beneath them. Although some studies have looked at the effect of the rider in terms of increased weight, asymmetry in the rider has not been related to laterality of the gait. The trot is a symmetrical gait where the limbs move in diagonal pairs and the weight is carried and propelled by the hind limb. The aim of this study was to assess whether postural asymmetries in the rider had an effect on the laterality of the horse in trot.

Following institutional ethical approval, seven horse-rider riding club combinations that had been together and sound for at least 1 year were used (Horse, mean age 10.4 years, $s = 1.62$ years; Rider, mean age 30.3 years, $s = 5.26$). Stride length in trot was measured five times on the left and right reins using videography and Ontrack™. Postural asymmetry in the rider was analysed by comparing the position of anatomical landmarks on both sides using digital photography and Ontrack™.

The results showed that the stride length on the better rein was significantly greater than that on the weaker rein. (Mean difference = 0.12 m, $s = 0.032$; $P < 0.01$) There was a significant negative correlation between the asymmetry in the trot and the asymmetry of the rider's iliac crest. ($R^2 = -0.394$; $P = 0.038$) and a positive correlation between iliac crest and scapulae asymmetry ($R^2 = 0.737$; $P < 0.01$).

The iliac crest and shoulder asymmetry seen is representative of shoulder-pelvis counter rotation. The horse's stride length is greater when the degree of pelvic asymmetry is less because there is a more equal weight distribution in the saddle. The horse will compensate for rider posture resulting in muscular imbalances, pelvic rotation and therefore asymmetry of the gait. Asymmetry at the pelvis has a greater effect on the horse than upper body asymmetries because of the position of the rider in the saddle.

The results suggest that rider posture should be assessed concurrently when analysing the equine gait for performance or lameness. Coaches and trainers should communicate the importance of dismounted

posture to the rider and emphasise the benefit of postural and core stability training.

SBIP2-07

Accuracy and reliability testing a transverse plane patellofemoral tracking calliper

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Patellofemoral pain syndrome (PFPS) is a debilitating condition and constitutes a high percentage of all knee complaints. Assessment of patellar tracking is currently expensive (magnetic resonance imaging [MRI]), has radiation side effects (X-ray), or is not a reliable measure (clinical observation). This study examines the validity of a patellofemoral tracking calliper (PFTC) design that would be used to diagnose patellar mal-tracking in the transverse plane. It is also thought that this could be used during treatment and rehabilitation to objectify the progress of a patient suffering with PFPS.

The PFTC was designed, built, and tested against a known gold standard of MRI in 30° of flexion with a contracted quadriceps in order to closely replicate weight bearing (WB) in the right knees of 21 participants. The participants were positioned with use of foam pads to ensure the goniometer measured 30° was maintained with a sand weight restricting leg extension movement. This was replicated for the calliper to test the identical position with use of spirit spirit bubbles to ensure precise horizontal and vertical positions were replicated. Ethical approval was obtained via an ethics committee.

The results demonstrated that there was strong reliability for the callipers with an r -value of 0.99 ($P < 0.01$) and a 3.86% coefficient of variation. The validity of the results obtained by the PFTC showed a +0.5 mm reading with a 95% confidence in the results from the PFTC being within ± 4 mm.

These values show promise when compared with previous studies of similar design. The design appears to be of use to the assessment and treatment community that would ensure that the general public and sports performers of all levels had access to a reliable and valid measurement device for patellar tracking. Observed problems were encountered with the MRI scanning due to orientation of the participants' knees and difficulty in maintaining a contracted state during the scan. The product design appears to be reliable and shows fairly good validity scores. However, further developments of the callipers are needed as well as further standardisation of positioning within the MRI scanner.

SBIP2-08**Anthropometric measures and prediction of competitive national rank in male high performance junior British surfers**

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Surfing is a high intensity intermittent exercise which in recent years has experienced a rapid increase in participation rates and growing professionalism amongst competitive athletes. Studies in a variety of sports have indicated that, unless one has a distinctive and specific body form suitable to the sport, there is little likelihood of success in top class performance (Lowdon, 1980: *Australian Journal of Sports Medicine* 12, 34–39). The aim of this study was to investigate the relationship between anthropometric measures and national ranking in male high performance junior British surfers.

Following institutional ethical approval and the completion of parental informed consent (children giving assent) high performance male surfers ($N=16$, age = mean 15.61, $s=1.06$ years) participated in anthropometric measures of stature, body mass, skinfolds (Tricep, subscapular, biceps, iliac crest, supraspinale, abdominal, front thigh and medial calf), girths (arm flexed and tensed, waist, gluteal and calf) and breadths (humerus and femur). All measures were taken in accordance with the guidelines of the International Society for the Advancement of Kinanthropometry (ISAK). These were used to calculate body mass index, waist to hip ratio and body fat percentage using the equation of Yuhasz (1975: *Physical fitness manual*. London: University of Western Ontario). A correlation analysis was performed using SPSS for Windows (V.15) between the measured physiological variables and the numerical national ranking of the subjects.

Significant ($P < 0.05$) correlations were found with Iliac Crest skinfold measurement $r=0.52$ ($R^2=0.27$) and body fat percentage $r=0.60$ ($R^2=0.36$). Thus the coefficient's of determination for these measures suggest that the iliac crest skinfold measure can explain 27% of the variance in ranking and body fat percentage explains 36% of the variance within the sample used. No other significant correlations were found.

The results suggest that within this age group body fatness may be conducive to surfing performance. This is supported by Felder *et al* (1998: *International Journal of Sport Nutrition*, 8(1), 36–48) and Lowdon (1980: *Australian Journal of Sports Medicine* 12,

34–39) who theorised that increased body fat may well protect the surfer from the cold and wet environment in which they perform.

SOTP2-09**The effects of combined glucose-electrolyte and sodium bicarbonate ingestion on prolonged intermittent exercise**

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Intermittent exercise results in greater carbohydrate utilisation and blood lactate when compared to continuous exercise matched for energy expenditure (Christmass *et al.*, 1999: *European Journal of Applied Physiology*, 80, 423–435). Consequently, the ingestion of both carbohydrate and a buffering agent prior to intermittent exercise may enhance performance. Therefore, the purpose of this study was to determine the effects of combined glucose and sodium bicarbonate ingestion upon prolonged intermittent exercise.

Nine healthy, males (mean age = 25.4, $s=6.6$ years, mean body mass = 78.8, $s=12.0$ kg) volunteered for the study which had received University Ethics Committee approval. Participants undertook four, 45 min intermittent cycling trials (15 × 3 min bouts: 90 s at 40% maximal oxygen uptake ($\dot{V}O_{2max}$), 60 s at 60% $\dot{V}O_{2max}$, 10 s maximal sprint, 20 s passive recovery) 60 min after the ingestion of placebo (PLA; 0.022 g · kg⁻¹ · body · mass⁻¹ sodium chloride, glucose-electrolyte (CHO; 8% glucose, 0.022 g · kg⁻¹ · body · mass⁻¹ sodium chloride), sodium bicarbonate (NaHCO₃; 0.3 g · kg⁻¹ · body · mass⁻¹) or combined glucose and sodium bicarbonate (COMB; 0.3 g · kg⁻¹ · body · mass⁻¹ of NaHCO₃, 8% glucose). Blood lactate, glucose, pH and bicarbonate (HCO₃) and gut fullness (GF) were measured pre-ingestion, post-ingestion and during exercise. Heart rate (HR) was continually monitored throughout exercise. Peak power was calculated for each sprint. Data were analysed via two-way ANOVA (trial × time) with repeated measure on both factors.

Blood pH, HCO₃ and lactate were greater post-ingestion and throughout exercise for NaHCO₃ and COMB when compared to PLA and CHO (main effect for trial; $P < 0.01$ all variables, effects size = 0.63, 0.72, 0.72, respectively). Blood glucose was greatest at 15 min post-ingestion for CHO (mean = 7.13, $s=0.60$ mmol · L⁻¹) when compared to COMB (mean = 5.88, $s=0.75$ mmol · L⁻¹) which was greater than NaHCO₃ and PLA (mean = 4.46, $s=0.59$, mean = 4.51, $s=0.56$ mmol · L⁻¹, respectively; main effect for trial $P < 0.01$, effect

size = 0.36). GF was lower during COMB compared to NaHCO_3 at 15 min post-ingestion ($P=0.04$, effect size = 0.12). No significant differences were observed for HR and peak power output ($P=1.00$, 1.00; effects size = 0.005, 0.012, respectively).

Although the ingestion of NaHCO_3 elevates blood pH, HCO_3^- and lactate post-ingestion and during prolonged intermittent exercise no improvements in performance were observed. Addition of NaHCO_3 to CHO may attenuate gastric emptying and reduce glucose absorption.

SOTP2-10

Hydration assessment of male national league field hockey players during tournament match play and training

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Due to the intermittent and less predictable nature of hockey compared to activities of a controlled intensity, the factors that influence hydration status are more variable. The aim of this investigation was to assess the hydration status of male National League hockey players during two tournament matches and one training session.

Ten male (Age mean 30, $s=7$ years) players consented to take part in this investigation which had received University ethical approval. Prior to matches and training nude body mass was recorded and urine samples collected for determination of osmolality (U_{osm}) and colour (U_{col}) as indicators of hydration status. Fluid intake and urine output during matches and training was also recorded. Data were analysed by one- or two-factor analysis of variance with repeated measures, with a subsequent Tukey *post hoc* test. Pearson's correlations were used to examine relationships.

Body mass losses for match 1 (mean 0.98, $s=0.75\%$), match 2 (mean 1.1, $s=0.98\%$) and training (mean 0.55, $s=0.34\%$) were not significantly different ($P=0.24$). U_{col} was not significantly different pre- and post-exercise ($P=0.60$; match 1, mean 4, $s=1$ versus 4, $s=2$; match 2, mean 4, $s=2$ versus 4, $s=2$; training, mean 3, $s=1$ versus 4, $s=1$) or between matches and training ($P=0.60$). No significant differences occurred in U_{osm} pre- and post-exercise ($P=0.49$; match 1, mean 561 $\text{mOsmol}\cdot\text{kg}^{-1}$, $s=285$ versus 441, $s=335$ $\text{mOsmol}\cdot\text{kg}^{-1}$; match 2, mean 450, $s=333$ $\text{mOsmol}\cdot\text{kg}^{-1}$ versus post-match 429, $s=300$ $\text{mOsmol}\cdot\text{kg}^{-1}$; training, mean 585, $s=334$ $\text{mOsmol}\cdot\text{kg}^{-1}$ versus post-training 560, $s=266$ $\text{mOsmol}\cdot\text{kg}^{-1}$) or between matches and training

($P=0.40$). There was a significant relationship between U_{col} and U_{osm} ($r=0.793$, $P<0.01$). Fluid consumption in matches (match 1 mean 0.69, $s=0.21$ $\text{L}\cdot\text{h}^{-1}$; match 2 mean 0.63, $s=0.05$ $\text{L}\cdot\text{h}^{-1}$) compared with training (mean 0.26, $s=0.45$ $\text{L}\cdot\text{h}^{-1}$) and sweat rates in matches (match 1 mean 1.20, $s=0.52$ $\text{L}\cdot\text{h}^{-1}$; match 2 mean 1.19, $s=0.61$ $\text{L}\cdot\text{h}^{-1}$) compared with training (mean 0.20, $s=0.17$ $\text{L}\cdot\text{h}^{-1}$) were significantly higher ($P<0.01$).

Euhydrated athletes usually have a $U_{\text{osm}}<700$ $\text{mOsmol}\cdot\text{kg}^{-1}$ and U_{col} of 1–3 (Casa *et al.*, 2005: *Current Sports Medicine Reports*, 4, 115–127), indicating that some players commenced matches and training with a sub-optimal hydration status. During matches, fluid losses through sweating were greater than fluid intake indicating inadequate fluid consumption. An effective fluid intake strategy, including using U_{col} to assess hydration status, is necessary to optimise hydration.

SOTP2-11

Hormonal and metabolic responses to hyperglycaemia during exercise in elderly men

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No study has investigated the hormonal and metabolic responses to maintained hyperglycaemia during exercise in elderly individuals. Therefore, the present study was designed to determine whether bypassing intestinal absorption using the hyperglycaemic clamp alters the responses of these parameters to 40 min cycling (60% $\dot{V}O_{2\text{max}}$) in elderly male participants.

Eight healthy males (Age mean 63.3, $s=5.2$ years) gave informed written consent to participate in the study after gaining approval from the University Ethics Committee. Participants reported to the physiology laboratory on two separate occasions, each of which were allocated for the performance of a 40 min exercise on a cycle ergometer at 60% $\dot{V}O_{2\text{max}}$ after 30 min of “prime” glucose or placebo infusion. Respiratory measures were undertaken during exercise at 10, 20 and 35 min and blood samples (20 mL) were taken before exercise (after 20 min rest), at the end of the 30 min prime infusion, during exercise (20 min) and immediately after exercise (40 min).

Although the fat oxidation were increased from 0.150 ± 0.05 to 0.200 ± 0.04 and 0.240 ± 0.04 g/min at 10, 20 and 35 min during exercise for saline

infusion (S) and values were higher than glucose infusion group (G), the differences were not statistically significant. Similarly, carbohydrate oxidation showed neither a main significant effect of condition ($F_{1,7}=0.94$, $P=0.366$) and time ($F_{2,14}=0.94$, $P=0.415$) nor a significant interaction between condition and time ($F_{2,14}=0.26$, $P=0.53$). Non-esterified fatty acid (NEFA) and glycerol concentrations for S were significantly higher than G ($F_{1,7}=21.1$, $P=0.002$) and ($F_{1,7}=16.5$, $P=0.005$), respectively, and a significant difference was observed only between their concentrations at -30 and 0 min. Glucose concentrations at 0, 20 and 40 min were significantly ($P < 0.01$) higher than -30 min for G group. Insulin concentration was significantly higher in G than S and a significant difference between -30 and 0 min was observed. The rate of glucose infusion increased from 1.00 ± 0.09 to 1.07 ± 0.21 g/min and remained almost at the same level up until 20 min of exercise after which the rate decreased for the remaining 20 min of exercise and reached to 0.83 ± 0.23 g/min at 40 min.

The present study demonstrated that the changes in metabolic and hormonal factors during exercise as a result of hyperglycaemia in health elderly participants are similar to those for young participants although this is not matched with appropriate changes in fat and CHO oxidation.

SOTP2-12

The effects of training with or without exogenous carbohydrate supplementation on the IL-6 response to an acute exercise stress

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Acute exercise increases plasma interleukin 6 (IL-6) concentration which functions as a “myokine” involved in glucose homeostasis during exercise. This response is attenuated when glucose is ingested during exercise or following exercise training. However, it is currently unknown if glucose ingestion during exercise and exercise training interacts to influence the IL-6 response to an exercise stress. Therefore, the purpose of this study was to evaluate the IL-6 response to an acute exercise protocol undertaken before and after a training programme completed with or without exogenous carbohydrate supplementation.

Following ethical approval, two groups of five active males performed 6 weeks of interval treadmill running training occurring twice per day, 2 days per week. Each training session consisted of five 3 min bouts at 90% $\dot{V}O_{2max}$ separated by 3 min active recovery periods. Group 1 consumed $8 \text{ mL} \cdot \text{kg}^{-1}$ of a 6.4% carbohydrate solution immediately prior to every second training session and a further $3 \text{ mL} \cdot \text{kg}^{-1}$ after 13 and 25 min of exercise. Group 2 followed the same drinking protocol but consumed a non-caloric placebo solution. The first and last training session were performed at the same absolute running speeds with venous blood collected immediately pre- and post-exercise and analysed for IL-6 using Luminex suspension array technology. Training induced significant ($P < 0.05$) improvements in $\dot{V}O_{2max}$ in both groups (Group 1, mean 10, $s=6\%$; Group 2, mean 7, $s=5\%$). Acute exercise increased IL-6 levels in both the untrained and trained state ($P < 0.01$), though the magnitude of this response was significantly less ($P < 0.05$) following training (Group 1: pre-training, mean 4.2, $s=2$ pg/mL, post training, mean 2.1, $s=0.5$ pg/mL; Group 2: pre-training, mean 4.2, $s=3.4$ pg/mL, post training, mean 1.6, $s=1.0$ pg/mL) and was not significantly affected by the provision of carbohydrate during training ($P > 0.05$).

In summary, exercise training induced a reduction in the plasma IL-6 response to an acute whole-body exercise challenge performed at the same absolute exercise intensity. The reduced IL-6 response following training seemed to occur independently of exogenous carbohydrate consumption during training. Given its role as a “myokine”, the attenuated IL-6 response to exercise following training is likely due to training-induced improvements in energy homeostasis during exercise.

SOTP2-13

The effect of glycemic index of high carbohydrate diets consumed for the duration of five days on exercise energy metabolism and running performance in females

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In males energy substrate selection and performance during endurance type exercise are not influenced by the glycemic index (GI) of high carbohydrate (CHO) diets consumed for a few days (Chen *et al.*, 2007: *International Journal of Sports Medicine*, published online). It remains unclear if the impact in females would be the same as in males. Therefore, the aim of the present study was to investigate the impact of 5 day high CHO intake with high and low GI diets on

energy substrate utilisation and exercise performance during running in the fasted state in females.

Nine healthy females (Age mean 25, $s = 3$ years; BMI mean 19.7, $s = 0.6$ kg/m² and $\dot{V}O_{2\max}$ mean 52.8, $s = 5.8$ mL/kg/min) performed three treadmill runs to exhaustion at 65% $\dot{V}O_{2\max}$ after habitual diet (Control trial), 5 days high CHO high GI diet (HC-HGI trial) and 5 days high CHO low GI diet (HC-LGI trial). During run blood and expired air was collected. Study was approved by Ethics Committee of Glasgow University. Data were analysed using one-way and two-way ANOVA with a Tukey post hoc test to allocate the differences.

Both high CHO diets were isoenergetic to habitual diet and provided more ($P < 0.01$) energy from CHO than the habitual diet. The GI of HC-HGI trial (GI mean 68, $s = 3$) was higher ($P < 0.01$) and GI of HC-LGI trial (GI mean 36, $s = 1$) was lower ($P < 0.01$) than of Control trial (GI mean 48, $s = 7$). GI of HC-HGI trial was higher ($P < 0.01$) than HC-LGI trial. During 90 min run plasma glycerol concentration and rate of fat oxidation was not different between HC-HGI and HC-LGI trials but values in HC-HGI and HC-LGI trials were lower ($P < 0.05$) than in the Control trial. No differences in these measures were found at exhaustion between trials. Time to exhaustion was longer after both high CHO trials (HC-HGI mean 146, $s = 22$ and HC-LGI mean 137, $s = 29$ min) than Control trial (Control mean 134, $s = 15$) but was not significantly different between trials.

We conclude that the extent by which high CHO diets consumed for the duration of 5 days reduce rate of fat oxidation during running in the fasted state in females is not influenced by GI of the diets. Thus, there is no need to consider GI of high CHO diet consumed for several days prior endurance event.

SOTP2-14

The effects of carbohydrate supplementation on multi-day wilderness expedition performance

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Wilderness expeditions expose participants to multiple stressors including prolonged exercise and nutrient restrictions. Inadequate nutritional intake may be detrimental to performance. Therefore, the purpose of this study was to investigate the effect of carbohydrate supplementation on physical performance, body composition and hydration status during a wilderness expedition.

With institutional ethical approval, 20 students (16 males, 4 females; Age mean 20.7, $s = 1.6$ years; Body mass (BM) mean 73.1, $s = 11.3$ kg) completed a five-

day, self-supported, expedition. Throughout, participants consumed *ad libitum* a 10% solution carbohydrate energy drink (CHO) or placebo (PLB) in a randomised, double-blind manner. Outcome measures were assessed pre, mid and post-expedition and included energy balance and fluid intake (self reported diary); body composition (four compartment model); hydration status (urine osmolality) and performance (time to complete a 400 m rucksack walking task). Data were analysed by mixed model ANOVA (allocation \times time).

Total dietary carbohydrate intake was significantly higher in participants receiving CHO (CHO *versus* PLB: mean 7.1, $s = 1.6$ *versus* 4.2, $s = 1.8$ g \cdot kg⁻¹ \cdot BM \cdot day⁻¹, $P = 0.001$, $\eta^2 = 0.5$). However, both CHO and PLB groups remained in negative energy balance, albeit trends of reduced energy deficit in the CHO group were observed (CHO *versus* PLB: mean -1882, $s = 1223$ *versus* -2981, $s = 1586$ kcal \cdot day⁻¹, $P = 0.094$, $\eta^2 = 0.1$). Consequently, fat mass decreased in both groups (pre *versus* post expedition: mean 20.7, $s = 7.4$, *versus* 17.7, $s = 6.9$ kg, $P = 0.001$, $\eta^2 = 0.6$). Time to complete the performance task was not affected by allocation ($P = 0.269$) but did tend to change over time (pre *versus* mid *versus* post expedition: mean 376, $s = 43$ *versus* 383, $s = 41$ *versus* 367 $s = 52$ seconds, $P = 0.088$, $\eta^2 = 0.2$). The CHO group had a greater fluid intake on day 5 compared with day 1 (day 5 *versus* day 1: mean 37.0, $s = 17.2$ *versus* mean 20.7, $s = 8.2$ mL \cdot kg⁻¹ BM, $P = 0.0495$, $\eta^2 = 0.1$) and their urine osmolality was lower post expedition (pre *versus* post expedition: mean 789, $s = 295$ *versus* 420, $s = 259$ mOsmol \cdot kg⁻¹, $P = 0.010$, $\eta^2 = 0.2$). In contrast, fluid intake (day 1: 22.3, $s = 16.0$ and day 5: 25.3, $s = 11.6$ mL \cdot kg⁻¹ BM) and urine osmolality (pre *versus* post expedition: 629, $s = 310$ *versus* 612, $s = 299$ mOsmol \cdot kg⁻¹) were unchanged in the PLB group.

During a 5-day wilderness expedition, participants were in negative energy balance. However, physical performance was unaffected, possibly because of beneficially altered body composition or adequate carbohydrate intake. Carbohydrate supplementation increased carbohydrate and fluid intake, which improved hydration status, but did not affect overall energy intake or performance.

SOTP2-15

Monitoring of hydration status during an elite mountain bike training camp

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Hydration status during endurance events can influence performance. Therefore, during training camps

hydration status should be monitored in order to maintain training quality. The aim of the study was to assess hydration status of elite mountain bike riders during a training camp and to compare two different methods of assessing hydration status. Eleven international (8 Males, 3 Females, Mean Age: 19 ± 4 years) mountain bikers were assessed. Measures of urine osmolality (UO) (Osmocheck, Vitech Scientific Ltd) and urine specific gravity (USG) using urine analysis dip sticks (Healchex, Q-Tech Medical LTD UK) were taken from three consecutive mornings and two consecutive evenings during a training camp as part of the preparation of the 2007 World Championships. Self reported fluid intake was also measured on day one and day two. Hypohydration was set at a UO of greater than 700 mOsmols/kg H₂O and a USG of 0.020. Measures of UO and USG were compared using Pearsons correlation coefficient. Change in UO and USG over the camp was analysed using a one way ANOVA. Post hoc analysis was undertaken with Tukeys HSD. There was a significant correlation between UO and USG ($r=0.71$, $P < 0.05$). There was no significant difference between morning UO on all three days (Day 1 AM mean = 521, $s = 156$ mOsmols/kg H₂O, Day 2 AM mean 550, $s = 107$ mOsmols/kgH₂O, Day 3 AM mean 588, $s = 115$ mOsmols/kgH₂O). No significant difference was shown between morning USG throughout all three days (Day 1 AM 1.012 ± 0.005 , Day 2 AM mean 1.012, $s = 0.003$, Day 3 AM mean 1.012, $s = 0.003$). Measurement of UO and USG both showed two individuals to be hypohydrated on Day 1 AM, and one person to be hypohydrated on both Day 2 AM and Day 3 AM. There was no significant difference between total drink volume consumed between day one (mean 4.2 L, $s = 0.7$ L) and day two (mean 4.6 L, $s = 1.7$ L). In conclusion athletes maintained hydration status throughout the camp. The use of a urine analysis dip stick was a convenient way to monitor hydration status through USG and can be easily used in the field.

SOTP2-16

Mental toughness in acl injury experience – what does mental toughness mean to an injured athlete?

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Research consensus has largely been achieved on “what mental toughness is” by researchers studying generic athlete samples (Jones *et al.*, 2002: *Journal of Applied Sports Psychology*, 14, 21-224) and sports specific elite athlete samples in cricket (Bull *et al.*, 2005: *Journal of Applied Sport Psychology*, 17, 209–

227) and professional football (Thelwell *et al.*, 2005: *Journal of Applied Sport Psychology*, 17, 326–332). However, research into what mental toughness (MT) is within Sports Injury and Rehabilitation experience remains scarce. Given mental toughness may well be contextually driven it was decided to study a purposive sample of five injured athletes in anterior cruciate ligament (ACL) rehabilitation.

All participants were elite professional athletes, either football/rugby players (mean age = 25.5 years, $SD = 4.23$), and were first-time referral patients receiving psychological support within a private medical practice in the NW of England, UK. Participants provided informed consent and granted permission for data to be shared within the research community. The research had a dual purpose (1) To find out what mental toughness meant to seriously injured athletes, and (2) To monitor if being a mentally tough athletes facilitates/inhibits the injury process (Levy *et al.*, 2006: *Journal of Sport Rehabilitation*, 15, 3).

Phase 1 employed semi-structured interview to explore how athletes explained and interpreted mental toughness in their specific injury situation. The emergent thematic constructs provide fresh evidence that MT is perceived differently by injured athletes to non-injured athletes and that specific characteristics of MT become more salient within each recovery phase. Given a totally different context, injured athletes explain mentally toughness differently to non-injured athletes. In the 2nd phase, all athletes registered moderate to high MTI values by the MTI instrument (Middleton *et al.*, 2004: *The Mental Toughness Inventory* (MTI), paper presented at the Association for Active Educational Research Conference, Aus), were re-interviewed to assess if MT is considered to be facilitative or inhibiting to successful rehabilitation (mean recovery = 13.1 weeks, $SD = 1.98$).

Findings demonstrated striking support that being mentally tough was perceived to facilitate successful recovery rather than inhibit it. The findings did not provide support for the opportunity of the darker side of MT to inhibit such recovery situations, with high MT athletes.

SOTP2-17

Sequential analysis in volleyball attack performance: a log-linear analysis

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Team sports performance is the outcome from interactive and cooperative efforts between players. In Volleyball, analysis of sequential plays has been

carried out according to outcome events such as game points, game final outcome and success in individual skills (Eom & Schutz, 1992: *Research Quarterly for Exercise & Sport*, 63, 3, 261–269). Despite the importance provided by this approach, knowledge about sequential events related with court-space organisation may provide more useful information. The purpose of this study was to evaluate first (setter space-to-attack space, attack space-to-attack performance) and second-order (setter space-to-attack performance) Volleyball sequential events. Data were gathered for 720 attack game actions (9 games and 44 sets from the European Championship – 2005). The studied variables and categories were attack efficacy (point; continuity not allowing adversary's contra-attack; continuity allowing adversary's contra-attack; error), attack space (without combination; combinations with central player near the setter; combinations with central player far from the setter; combinations between two players with chances of places) and setter space (excellence zone; acceptable zone; non-acceptable zone). Log-linear procedures were used to analyze the nature and degree of the relationship in first and second-order sequential events. Goodness of fit (Likelihood Ratio = 14.86, $P = 0.67$) assessed the fit of the model and the linearity of relationship between variables. Results showed a significant dependency in setter space-to-attack space (Cui-square_{1,6} = 43.06, $P < 0.01$) and in setter space-to-attack performance (Cui-square_{1,6} = 26.41, $P < 0.01$). Results from attack space-to-attack performance were not statistically significant (Cui-square_{1,9} = 6.87, $P = 0.65$). Odds ratio value confirmed that the probability of scoring points is 2.38 higher when the setter is into the excellent zone. In summary, results have provided valuable aids to understand court-space attack organisation, suggesting that court-space where the attack is done and performance achieved depends upon the court-space where the proceeding action is done.

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SOTP2-18

Long-term development and sport specialisation

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One issue of discussion among researchers examining sport specialisation is whether aspiring expert athletes need to limit their childhood and youth sport participation to a single sport. An opposite perspective suggests a focus on involvement in a number of different sports before specialising in later stages of development (Baker, 2003: *High Ability Studies*, 14, 85–94). Empirical research supporting the early diversification approach is limited, despite research from psychology, physiology and motor learning support its validity. No standardised method has been proposed to collect data about the development of expert performance in team sports. Thus, the purpose of this study was to characterise the long-term player development stages in high-performance basketball players, in order to analyse the starting ages and the training activities performed through lifespan.

To accomplish this, 1170 basketball players filled out a previously validated questionnaire based on retrospective information related to the training activities performed during their involvement in sport (Côté *et al.*, 2005: *Journal of Applied Sport Psychology*, 17, 1–19). The sample was divided according to gender and stage: initiation (between 6 and 10 years of age, $n = 80$ boys and $n = 64$ girls), orientation (11–14 years, $n = 201$ boys and $n = 129$ girls), specialisation (15–18 years, $n = 277$ boys and $n = 196$ girls), and high-performance (19 years and beyond, $n = 71$ men and $n = 125$ women). Differences between samples were analysed through non-parametric Jonckheere's trend test and corresponding effect sizes.

The results supported that long-term player development starting age occurs preferentially between 6 and 10 years. Also, the results demonstrated that a significant part of high-performance players specialised between 11 and 14 years, suggesting that early specialisation in basketball is not a condition for the success of the long-term player development. Differences between orientation, specialisation and high-performance male players allowed us to distinguish the player's samples and their long-term development. Besides the fact that high-performance players focus in basketball in later ages, another important finding of our study indicated that in the earlier stages of the long-term development, high-performance males practice more throughout the year, mostly basketball, individual sports and other team sports. By the other hand, high-performance females seem to prefer basketball and individual sports. These facts reinforced the significant differences in the time dedicated to all training forms (related and specific). Results also suggested that an early diversification and a later basketball specialisation

could help players developing performance proficiency (in both genders).

SOTP2-19

The path to the expertise in Spanish basketball coaches

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The aim of this study was analysing how 16 Spanish expert coaches have acquired their expertise in top-level basketball. Emphasis was made on examining their stages of evolution as coaches as well as establishing the factors and educational resources that have led to their success. In order to attain these objectives, a qualitative-type study using the biographical method and semi-structured interview was undertaken. Each interview was transcribed verbatim and the data were analysed using the principles of constant comparative analysis as described by Côté *et al.* (1993: *The Sport Psychologist*, 7, 127–137).

The results concerning the factors associated with the development of coach expertise were divided into five different topics: (i) Basic factors (specific knowledge, deliberate work and a great deal of experience acquired over many years as coaches); (ii) Emotional factors (motivation, commitment to work and on-going passion for the sport); (iii) Specific factors (adaptive expertise, leadership, communication); (iv) Contextual factors (family,...); (v) Other factors (agent,...). Also, results reflected four formation evolutionary stages. The first stage was identified by the praxis of imitation. The second was characterised by a reflexive practice. The third stage was characterised by an enormous autonomy as coaches. The expert stage corresponded to coaches able to performing successful decisions in competition.

Finally, informal education modes have played an important role in coaches' career; this included day-to-day praxis of coaching (situated learning) together with reflection on the praxis, informal knowledge networks or social learning and mentoring.

SOTP2-20

Home advantage in the Spanish professional league

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It is commonly believed that a team which is playing under a balanced home and away schedule perform better at home than away. This concept is called home advantage and it has been studied regarding Association Football. Pollard (2006: *Journal of Sports Sciences*, 24, 231–240) found clear variations in home advantage throughout the countries. In this way, Pollard (1986: *Journal of Sports Sciences*, 4, 237–246) showed that the number of home wins from 1888 to 1984 has exceeded the number of away wins by a considerable margin. Furthermore, Thomas *et al.* (2004: *Perceptual and Motor Skills*, 99, 1212–1216) found similar results in First Division Football League (1984–1991) and English Football Premiership (1992–2003). For example, for seasons 1992–2003 in which 4426 matches were played, 2036 were home wins, 1174 away wins and 1216 home draws. Besides, Jacklin (2005: *Journal of Sports Sciences*, 23, 669–679) indicated that in each of the seasons since the Second World War (1946–47 to 2002–03) there were more home wins than away in the two top English Football Division. Thus, this study was specifically focussed on looking at the home advantage in the Spanish Professional First and Second Division.

The sample comprised 21007 matches of the two top Spanish Professional Divisions that belonged to 27 seasons from 1980/1981 to 2006/2007. Furthermore, the resulting sample split yielded 9993 matches for the Spanish First Division and 11014 games for the Second Division. Archival data were obtained through www.lfp.es.

Results (Table I) showed great differences in home advantage in both First and Second Division in the Spanish Professional League during the period from 1980–2007. In summary, there were a total of 10175 home wins, 4811 away wins and 6021 home draws joined both divisions.

The outcomes of this work strongly support the notion that there is a clear home advantage in the top two divisions of Spanish football. This study has not considered the reasons why a home advantage is observed. Research on crowd effects, travel, familiarity, rules, psychological factors, referee bias, territoriality could help in the light of enhancing the home advantage knowledge in the Spanish football.

Table I. Results in the Spanish professional first and second division from 1980 to 2007.

	Home wins	Home draws	Away wins	Home goals	Away goals
Top division	5010	2706	2277	15518	9965
Second division	5165	3315	2534	15893	10648
Total	10175	6021	4811	31411	20613

SOTP2-21

The effects of point system and team quality on home advantage

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Home advantage in sport is well documented. Most research has focussed the home advantage on Courneya & Carron's (1992: *Journal of Sport & Exercise Psychology*, 14, 13–27) grouping of crowd, learning, travel and rule effects. Other factors like point system were introduced by Jacklin (2005: *Journal of Sports Sciences*, 23, 669–679). The author revealed that changing from two points to three points for a win has led to a reduction in the home advantage. Pollard (1986: *Journal of Sports Sciences*, 4, 237–246) and Thomas *et al.* (2004: *Perceptual and Motor Skills*, 99, 1212–1216) found similar results. Thus, the aim of this study was to investigate the effects of the point system and team quality on home advantage in a long-term trend in the Spanish Professional First and Second Division.

The sample comprised 86 teams of the Spanish Professional First and Second Division that belonged to 27 seasons from 1980–81 to 2006–07. Two groups were created within each division (first 10 teams for high level and rest of the teams for low level). The Spanish professional point system league changed in 1994/95 when a won match was scored with three points and one point for a drawn match. The resulting sample split yielded 530 days for First Division and 558 days for Second Division. Archival data were collected through www.lfp.es. After classifying divisions into two groups based on a split, the multianalysis of variance (MANOVA) 2×2 (team level \times point system) did not indicate an interaction (Wilks $\lambda_{0,829} = 0, 987$; $P = 0.578$; effect size $\eta^2 = 0.013$) in First Division. Nevertheless, a significant main effect was found for Second Division (Wilks $\lambda_{2,856} = 0, 96$; $P = 0.004$; effect size $\eta^2 = 0.40$). Univariate analysis revealed differences in mean home draws and mean away lost ($P < 0.05$). High levels teams tied with less frequency with the old system (0.262) than with the new one (0.290). On the other hand, low level teams tied more with the old system (0.326) than now (0.317). Furthermore, low level teams lost their away games with less frequency now (0.493) than before (0.597), whereas the decreasing in high level teams is less comparing before the three points system (0.424) and today (0.364).

Current results may suggest a greater impact of point system in the Second Division, probably due to an increase of equality in this competition.

SOTP2-22

Club sport and the developmental model of sports participation: An exploratory study of the UK perspectiveM. W. Bridge^{1,2} & M Toms¹¹*School of Education, University of Birmingham and*²*School of Sport & Exercise Sciences, University of Birmingham, UK*

In the UK, the work of Balyi (2002: *Faster Higher Stronger*, 14, 6–9) and Côté and Hay (2002: In *Psychological foundations of sport*, edited by J. M. Silva & D. Stevens. Boston: Allyn & Bacon) are well established as frameworks for participation, athlete socialisation and development. The former has most recently underpinned much of the UK's athlete development framework, but is currently under considerable academic scrutiny and critical review. The latter, whilst being received far more coherently within academia, requires a wider cultural and educational context for the UK (Kirk, 2005: *European Physical Education Review*, 11, 239–255). This article highlights the results of an exploratory study into club sport participation patterns.

After ethical approval a questionnaire was distributed to a sample of 140 University undergraduate sports students (65 male and 75 female). They were asked to think retrospectively about their club sport participation between the ages of 5 and 20, and to highlight: (i) the sports they played; (ii) the age they played these; (iii) the level they played (e.g. Club, Regional, National); (iv) the hours of practice they undertook per week; and (v) the reason(s) for drop out of the sport.

On analysis, the results of the questionnaire identified a different pattern (see Figure 1) of participation to that highlighted by Côté & Hay (2002: In *Psychological foundations of sport*, edited by J. M. Silva & D. Stevens. Boston: Allyn & Bacon), with the phases of “Sampling”, “Specialising” and “Investing” occurring much later in the students' sporting lives (a delay of around 4 years). It was noted that this pattern mirrors the educational changes and age groupings of club sport within the UK, and suggests that this structure can stifle the “Investment” phase of sporting talent development. The data further reflected the reasons for drop out identified by Côté & Wall (2005: *Physical Education & Sport Pedagogy*, 12, 77–87) (e.g. lack of time and clashes between sports).

The implications of this study are significant for UK coaches, teachers, sports governing bodies and policy makers. It indicates a need to further explore the area of club sport participation in the UK in more detail in order to influence and better understand participation patterns at all levels.

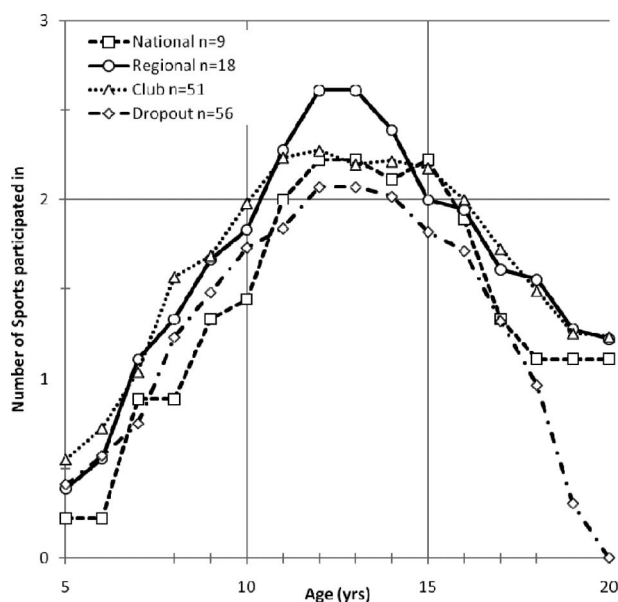


Figure 1. Number of sport participated at different levels of competition at 20 years old.

SOTP2-23

Judges scoring patterns within the dressage phase of an elite level eventing competition

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The horse sport of eventing is a three phased competition consisting of dressage, show jumping and cross country. The dressage phase is subjectively assessed between one and three judges depending on the level of competition. Biasing in judging is the subject of much debate and anecdotal evidence amongst competitors. Previous research has indicated that biasing does occur within some subjectively judged sports (Findlay & Ste-Marie, 2004: *Journal of Sport & Exercise Physiology*, 26, 154–166). The problem of subjective judgment in equine sports has been demonstrated (Whitaker & Hill, 2005: *Equine and Comparative Exercise Physiology*, 2, (2), 97–104). This study investigated scoring patterns within the dressage phase of an elite level eventing competition.

Data were collated from the dressage phase of the 2006 Burghley International Horse Trials. In total 81 competitors performed in this phase of competition. Competitors were scored within the phase by three independent judges (Judges E, C and M). Descriptive statistics and measures of dispersion were returned for the data set. Comparative analysis between judges scoring patterns was undertaken via

ANOVA. Analysis was performed for the population as a whole. Further investigation was performed on the population after it had been segmented into quartiles; top ranked quartile ($n=20$), second and third ranked quartiles ($n=41$) and bottom ranked quartile ($n=20$).

Normal distribution was observed in the scoring patterns for all three judges. Analysis of variance showed that within the whole population no differences of significance were observed between the three judges. However analysis of the population via quartiles showed that judge C's scoring pattern was different to judges E and M within the bottom quartile of competitors ($F=3.853$, $df\ 59$, $P<0.05$). Judge C returned a mean score of 145.4 penalties, $s=10.2$, whilst judge's E and M returned the same mean score of 151.6 penalties, $s=7.4$ and $s=6.5$ respectively.

This study indicates that within the whole population there is no significant variation in scoring patterns within the dressage phase of competition. It however highlights that this stability is not apparent when the population is interrogated in more detail. Within the bottom quartile it is apparent that one judge is scoring significantly different from others. Within any subjective scoring system used in sport such variations need to be carefully considered in the context of evaluating, comparing and recording performance.

SOTP2-24

Penalty score analysis in the modern pentathlon (IUPM World Cup Qualifiers 2007)

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A number of authors have speculated on the interaction and relative effect of discrete phase performance within multiphase sports (Cox & Dunn, 2002; *The Statistician*, 51(2), 179–137). This study undertook a preliminary investigation of associations and distributions for discrete phases and final penalty score for the modern pentathlon.

Data were collated from all competitors ($n=422$) participating in the 2007 IUPM Pentathlon World Series Qualifiers. The structure of competition meant that only the top 35 competitors completed the riding phase ($n=214$). The performance for each phase of competition was observed via penalty score within the specific phase, additionally total final penalty score was investigated. Descriptive statistics, measures of distribution (via skewness test and box plots) were reported for each phase. Measures of association (via Spearman's rank correlations) between phase penalty scores and final penalty score were examined.

Normality of distribution was observed within the data set with the exception of riding (skew -2.24) and running (skew -1.34). Table I shows penalty scores for riding had the strongest association with final penalty score ($r_s = 0.611$, $P < 0.01$). Very weak positive associations were observed between fencing and swimming, fencing and running and swimming and running. No other significant inter phase relationships were observed.

Analysis of data distribution via box plots (Figure 1) shows considerable variation within the scoring patterns for each data set. Shooting is the only discipline to not suffer from outlier or extreme outlier effect. The effect is most extreme in the riding phase. Penalty scores ranged from 44 to 1200, the standard error mean was 15.89.

This preliminary investigation indicates that the penalties scored in the riding phase of competition have the greatest association with the final penalty score. However it also indicates that the penalties

scored in the riding phase exhibit extreme variation. It is also interesting to note that the associations between disciplines are observed to be relatively weak if they exist at all.

SOTP2-25

FIFA football world ranking system and FIFA World Cup performance

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Rating and ranking systems are widely used within sport to make assessments of the performing athlete. One such system used within team sport is the official FIFA Football World Ranking System. The rankings system was established in 1992 and has subsequently undergone a variety of changes in the

Table I. Spearman rank correlation co-efficient for phases and final penalty score (IUPM World Cup Qualifiers 2007).

	Shooting	Fencing	Swimming	Riding	Running
Final	0.407(**)	0.481(**)	0.326(**)	0.611(**)	0.403(**)
Shooting		0.023	-0.032	0.015	-0.082
Fencing			0.130(**)	-0.005	0.106(*)
Swimming				0.100	0.131(**)
Riding					0.085

Note: Correlation is significant at the 0.01 level (**) at the 0.05 level (*) (2-tailed).

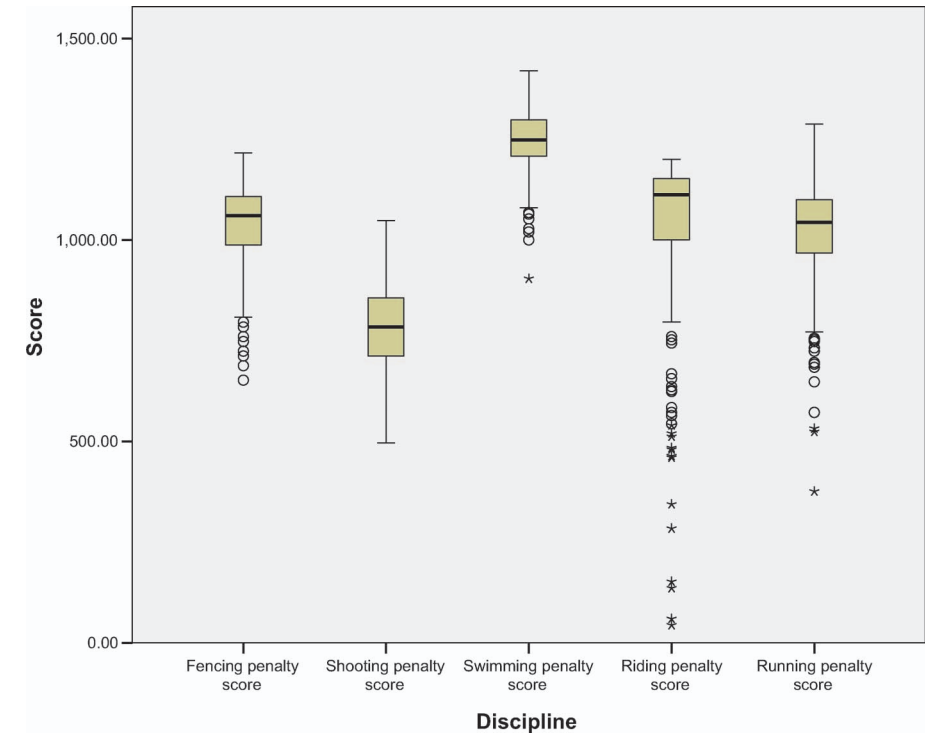


Figure 1. Box plots for phase penalty score (IUPM World Cup Qualifiers 2007).

wake of criticism as to its accuracy (Stefani *et al.*, 2007: *Journal of Quantitative Analysis in Sports*, 3(3), 3). This study reviewed FIFA rankings for teams at the start of FIFA World Cups and subsequent performance within those World Cups.

Data were collated from four FIFA World Cups (1994–2006) in total 120 teams. Wilcoxon matched pair test was applied to the data set. Ranked finishing position within World Cup and official FIFA ranking at the start of the World Cup was compared via Spearman's rank correlations for the whole population. The data were further interrogated; correlations between FIFA rank and top four finishers were performed. Additionally median FIFA rank and finishing position were reported for top four finishers, quarterfinalists, those teams progressing to the second round, third in group and fourth in group.

FIFA rankings for teams competing in the World Cup ranged from 1st through to 74th. Wilcoxon matched pairs test demonstrated a difference between median FIFA rank (20th) and finishing position within a World Cup (9th) ($Z = 6.089$, $P < 0.001$). Overall association between FIFA rank and World Cup finishing was $r_s = 0.408$ ($P < 0.001$). Association between the top four's FIFA rank and finishing position was $r_s = 0.590$ ($P < 0.01$). Median FIFA rank for top four finishers was 14.5, quarterfinalists 10, second round 15.5, finishing third in group 26 and finishing fourth in group 30.5.

This study indicates that the overall association between FIFA rankings and final finishing position is only moderate to weak; it is however more strongly associated when the top four finishers are examined independently. Teams are finishing considerably higher in the World Cup than their FIFA ranking indicates (median comparisons). However it is also apparent teams with high FIFA rankings have participated within the World Cup; these "outliers" need to be considered carefully before any firm conclusions can be drawn. It is also interesting to note that the median ranking of quarterfinalists was 4.5 places better than those that went on to qualify for the last four.

SOTP2-26

An interdisciplinary approach to making weight in lightweight rowers

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This case study focuses on the interdisciplinary preparation of the male coxless lightweight four competing in the European Universities Rowing Regatta. Acute weight loss is detrimental to perfor-

mance (Slater *et al.*, 2005: *Medicine and Science in Sports and Exercise*, 37(8), 1387–1394) and current sporting practises in recovery may be ineffectual (Slater *et al.*, 2005: *Medicine and Science in Sports and Exercise*, 37(5), 860–866). Initial consultations indicated the crew relied on "lay" information with little formal sport science knowledge to make weight and had previously experienced difficulties in making weight, including the use of inappropriate methods. Our aims were to focus on long-term weight loss to avoid acute losses > 1 kg in the 24 h prior, maximise training quality in the taper and ensure recovery nutrition following the latest sports nutrition advice.

An ISAK anthropometrist carried out assessments eight and four weeks prior to competition for determination of adiposity and lean mass according to Lee (2000: *American Journal of Clinical Nutrition*, 72(3), 796–803). This informed subsequent weight loss goals and dietary interventions. Nutritional consultations focussed on creating a positive energy balance around training whilst maintaining an energy deficit of 0.5–0.9 kg/week. Sport science support included monitoring of training quality, individualised strength and conditioning programmes and a practise race 10 days before competition.

At the second assessment, the sum of seven skinfolds reduced from an average of 48.0 mm (range 41.1–53.0 mm) to 39.0 mm (range 36.5–40.3 mm). Lean mass was maintained (47.5 *versus* 47.1 kg), although there was individual variation (3.5% to -0.8%). Average BM declined from 74.5 to 70.6 kg (mock race) and 69.7 kg on race day. During the practise race the crew came in ~ 2 s faster than their season's best in a 2 km trial.

This case study highlights the necessity of an interdisciplinary approach when working with elite sportsmen. The intervention was successful in encouraging long-term weight management strategies, maximising training quality rather than volume and also ensuring recovery nutrition was adequate. A pleasing note was that 10 days before the race, three of the crew made weight, had an opportunity to practise and refine recovery strategies and still set a season's best. Overall, the crew maintained their bronze medal in the regatta. The key challenges were sharing information amongst the team to enable individualised support and working against established sporting culture to elicit a positive change.

SOTP2-28

Does enhanced feedback using video technology improve sprint start time?

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Video instruction is a relatively new method of practice and it is not widely used in sprinting. However biomechanical feedback has been used to train athletes with sprint start techniques over the last few years. Video analysis software (Silicon Coach) has been used to help performers by analysing complex movements. The aim of the study was to determine: (1) whether providing biomechanical and performance feedback improves sprinters' first 10 m run from blocks, (2) whether there was a relationship between selected angles and time in seconds, (3) athletes' experience of the feedback provided by the coach/researcher.

Seven sub elite participants participated in this study. Group One, added immediate visual feedback ($N=3$) and Group Two, verbal feedback ($N=4$) completed three 10 m sprint tests; pre, post and retention. Firstly immediate visual feedback was provided after each sprint, and then Subject-specific angle (rear ankle, front ankle, rear knee, front knee, and arm) was measured using Silicon Coach. A 3×2 , two way mixed ANOVA was used to analyse the data. Significance was set at $P < 0.05$.

Within groups, analysis showed no significant difference between sprint start times. However, an interesting trend was observed; pre *versus* post (mean diff = 0.187; $P = 0.285$), pre *versus* retention (mean diff = 0.080; $P = 1.000$), post *versus* retention (mean diff = 0.107; $P = 0.225$).

With regard to angles and time, there was no significant correlation between angles and time, for either Group One or Group Two. However when both groups were combined there a significant relationship was observed between rear-ankle and time at retention ($R = 0.914$, $P = 0.004$, $n = 7$). Finally, the athletes and their coach were interviewed to elicit responses about their perceptions of the effect (if any) of the feedback on performance. All participants in Group One agreed that biomechanical and visual feedback helped them to correct their technique.

Although no significant differences for the effect of enhanced feedback on sprint time were observed between the two groups, the results identified a trend which was supported by the athlete's feedback. This may suggest that this are of study needs further investigation. This study also found a correlation only between rear-ankle and time. Further study, using a larger sample group, may be warranted to ascertain the effect of Subject-specific angle on sprint start times.

SOTP2-29

A qualitative study into the experience of choking in karate

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Choking under pressure describes "the occurrence of inferior performance despite individuals striving and situational demands for superior performance" (Baumeister, 1984: *Journal of Personality and Social Psychology*, 46, 610–620). The current study was conducted based on suggestions for future research concerning the need to address choking under pressure in a qualitative paradigm (Gucciardi & Dimmock, 2008: *Psychology of Sport and Exercise*, 9, 45–49). Specifically, the aim was to identify the psychological and behavioural characteristics of the choking experience in elite Karate performers.

Following ethical institutional approval, eight elite Shotokan Karate performers, five females and three males aged 18–35 (age mean 27.13, $s = 7.62$) were interviewed about their most memorable experience of choking during competition. To meet the definition of elite, participants were all current or former members of a national Karate team and had competed internationally for at least 3 years (time spent competing on the national team in years, mean 5.88, $s = 3.44$). Interviews were transcribed verbatim.

Following inductive content analysis, five general dimensions were identified: (1) "experience prior to choking" comprising the higher order themes of somatic feelings, positive cognition, negative cognition, environmental characteristics; (2) "perceptions during the choking experience" comprising anxiety, perceived pressure, self-presentational concerns, conscious control, and paralysis; (3) "perceptions directly after choking experience" comprising embarrassment and negative appraisal; (4) "concerns associated with future performances" comprising rumination, avoidance, and negative self-doubts; and (5) "personal explanations for choking experience" comprising internal and external attribution. Findings are consistent with Murayama, Takayuki and Hiroshi Sekiya (2007: *Journal of Sport & Exercise Psychology*, S191) who, identified "pressure", "attention", "anxiety", "negative cognition", "disruption of motor control" and "physical dysesthesia" as general dimensions relating to choking under pressure.

The present study concludes that choking evokes feelings of movement paralysis that are accompanied by panic and fright. Consequently, behavioural modification and negative cognitive and somatic responses occur that hinder the automatic function representative of optimal performance. Current findings, along with other studies (e.g. Drinan, Williams, Marchant, & Wang, 2000: *Australian Journal of Psychology*, 52, 79; Murayama *et al.*, 2007) outline the usefulness of, and the need for, qualitative research in gaining a subjective understanding of the choking process.

SOTP2-30

The effects of multiple cold water immersions on indices of muscle damage

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Exercise-induced muscle damage (EIMD) is known to result in a reduction in contractile function causing muscle soreness that results from tissue microtrauma initiated by high tension produced during eccentric contractions and further exacerbated by the subsequent inflammatory responses. A fast recovery may be important for athletes involved in a training programme, or who have a competition schedule that requires more than one high intensity effort within a short period (Chen & Nosaka, 2006: *Journal of Strength and Conditioning Research*, 20, 108–116). In light of the limitations regarding exercise specificity, immersion temperature and duration, the aim of this study was to elucidate the efficacy of repeated cold water immersions (CWI) in the recovery of EIMD elicited by plyometric exercise.

Following institutional ethical approval 18 physically active male participants were recruited for the study. After a bout of damaging eccentric exercise on the legs, the participants were equally, but randomly allocated to either a cryotherapy treatment or control group. Isometric force (MVC), muscle soreness (DOMS), serum CK, thigh circumference and range of motion (ROM) were recorded pre-exercise and at 24 h increments for 96 h, in addition MVC was recorded immediately post-exercise. The cryotherapy group underwent a seated immersion (up to iliac crest) in an inflatable ice bath for 12 min (15°C); this treatment was applied immediately post-exercise and every 24 h thereafter for the following 3 days.

Values for MVC, DOMS, CK and thigh circumference showed significant time effects ($P \leq 0.01$), although there were no interaction or group effects ($P \geq 0.05$). The biggest decrement in MVC was observed immediately post-exercise. In both groups, CK activity peaked 24 h post-exercise and returned to baseline values by 96 h post-exercise. Muscle soreness for both groups peaked 48 h post-exercise and returned to baseline levels by 96 h post-exercise.

Contrary to the positive effects that have been found in some studies, summarised by Wilcock *et al.* (2006: *Sports Medicine*, 36, 747–765), the repeated applications of cryotherapy that were administered in the present study did not enhance the recovery of any dependent variable. These findings concur with a number of other cryotherapy investigations (Howatson *et al.*, 2005: *Scandinavian Journal of Medicine and*

Science in Sports, 15, 416–422). Perhaps a positive point is that the immersions do not seem to have a detrimental effect on recovery, although the impact on adaptation or repeated bout effect has yet to be elucidated.

SOTP2-31

Effect of a carbohydrate mouthwash on skill performance in male hockey players

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Carbohydrate mouthwash has been found to improve cycling time trial performance by 2.9% (Carter *et al.*, 2004: *Medicine and Science in Sports and Exercise*, 36, 2107–2111). However, an investigation into the effect of carbohydrate mouthwash on skill performance has never been conducted. Therefore, this study examined the effects of a carbohydrate mouthwash on field hockey skill performance.

Seven male university first team field hockey players (age mean 21, $s = 2$ years; height mean 183, $s = 5$ cm; mass mean 83, $s = 7$ kg; $\dot{V}O_{2\max}$ mean 57.6, $s = 3.2$ ml \cdot kg⁻¹ \cdot min⁻¹) volunteered to participate and gave their informed consent. Institutional ethical approval was obtained. Participants performed an intermittent treadmill protocol (on a motorised treadmill) designed to reflect the intensity of hockey match play. This involved two “halves” of 25 min separated by a 10 min rest period (half time) including varying speeds of 0, 6, 7, 20 km/h and speeds equating to 75 and 95% $\dot{V}O_{2\max}$. Prior to and immediately after (~ 5 min) the intermittent running, an electronic, computer recorded, hockey specific skill test (assessing accuracy and decision making) was performed. The protocol was carried out on two occasions separated by a 7d interval during which a carbohydrate (CHO) mouthwash (6% maltodextrin and 3% fruit cordial) or placebo (PLA) mouthwash (3% fruit cordial) were administered in a double blind design. Heart rate, blood glucose and lactate, rating of perceived exertion (RPE) and oxygen consumption ($\dot{V}O_2$) were measured at intervals throughout the treadmill protocol.

Skill performance improved in five out of seven participants following the rinsing of CHO compared to the PLA trial represented by a decrease in the total time to complete the skill test (CHO mean 95.14, $s = 13.82$ s; PLA mean 105, $s = 11.80$ s). Following CHO rinsing, decision making time improved, decreasing in six out of seven participants compared to the PLA trial (CHO mean 4.31, $s = 0.43$ s; PLA mean 5.32, $s = 1.56$ s). However, these improvements were not significant ($P = 0.119$, $P = 0.185$

respectively). There was a significant decrease in heart rate between the two halves of the treadmill protocol in the CHO trial (mean first half 155, $s = 9$ beats \cdot min⁻¹, mean second half 154, $s = 6$ beats \cdot min⁻¹ respectively; $P = 0.007$.) There were no significant differences in blood glucose and lactate, RPE and $\dot{V}O_2$ throughout the protocol.

In conclusion, there appeared to be a positive effect on skill performance, although not statistically significant, the reasoning behind which warrants further investigation.

SPSP2-32

“Breaking the ice”: Understanding skating relationships from a tripartite efficacy perspective

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In the context of dyadic enactment in sport, athletes invariably develop a set of efficacy beliefs that not only include perceptions of personal agency (i.e. self-efficacy), but also consist of a set of relational efficacy beliefs that involve the dyadic partner as well (cf. Lent & Lopez, 2002: *Journal of Social and Clinical Psychology*, 21, 256–286). Lent and Lopez (2002) conceptualised two distinct types of relational efficacy in the form of other-efficacy and relation-inferred self-efficacy (RISE), which together with self-efficacy constitute a “tripartite model” of efficacy beliefs within dyadic settings. Although preliminary research evidence suggests that these tripartite beliefs might be important social cognitions, responsible for shaping relationship development, functioning, and maintenance in sport (e.g. Jackson, Knapp, & Beauchamp, 2007: *Journal of Sport & Exercise Psychology*, 29, 170–189), at present relatively little is known about the antecedents of these tripartite efficacy constructs within elite athlete dyads.

The overall purpose of this study was to identify sources of each tripartite efficacy perception, as held by members of elite figure skating couples. Following institutional ethical approval to conduct the research, members of five British national-level intact skating pairs (Age mean 19.50, $s = 2.59$) were interviewed separately and consecutively. The interviews were audio-recorded, transcribed verbatim, and subsequently content analysed, using a combination of deductive and inductive procedures. Sources of the tripartite efficacy constructs emerged that involved

perceptions regarding (a) “the self” (e.g. athlete’s personal affective state, personal successes), (b) “the partner” (e.g. trust, comparison with previous partners), (c) “the dyad” (e.g. shared training experiences, conjoint performance successes), and (d) “the external environment” (e.g. audience, training venue). Conceptually, the results of this study provide unique insight into some of the “general” and “sport-specific” determinants of relational efficacy within figure skating partnerships. Furthermore, from an applied perspective, the sources that emerged in this investigation hold implications in terms of facilitating effective dyadic functioning in elite sport.

SPSP2-34

Attentional demands and skilled motor performance: A study of attentional focus

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With the inception of the constrained action hypothesis, attentional focus has been a topic of much recent interest. Specifically, Wulf *et al.* (2001: *Quarterly Journal of Experimental Psychology*, 54A, 1143–1154) reported that an external focus of attention yielded enhanced performance coupled with lower vocal reaction times during a dynamic balance task. However, there is currently a lack of research directed towards identifying whether these findings extend to discrete multi-articular actions. Therefore, the aim of this study was to examine the effects of focus of attention on both performance and vocal reaction time during a soccer chipping task.

With institutional ethics approval, 15 skilled football players (Age mean 20.54, $s = 2.14$ years) were randomly allocated into one of three groups (internal focus, external focus and control). Each participant was classified as skilled using a performance pre-test. Each participant performed 20 consecutive trials chipping a regulation indoor football towards a series of five concentric target zones marked out on the floor. Five points were awarded for hitting the central target zone whereas points were deducted for hitting more distal target zones. The internal focus group were provided with task-relevant information and instructed to focus on technical aspects of the movement, whereas the external focus group were instructed to focus on the trajectory of the ball, landing it within the central target area. The control group were given no further instruction. Finally, during each trial the attentional demands of the task were assessed using a probe reaction time test.

Between-participants analysis of variance revealed significant main effect for both performance score ($P=0.0001$, $\omega^2=0.715$) and vocal reaction time ($P=0.0001$, $\omega^2=0.753$). *Post-hoc* tests revealed that the external focus group demonstrated greater performance success and lower vocal reaction times than both the internal focus group and control group ($P<0.05$). The findings of the current study supported previous research pertaining to dynamic balance tasks. From a dynamical systems perspective, it could be argued that an external focus allowed skilled performers to self-organise based upon the interacting constraints on action. An internal focus of attention, on the other hand, increased the attentional demands of the task, and degraded performance by overriding the intrinsic dynamics of the human movement system.

SPSP2-35

An exploration of psychosocial competencies in elite youth talent development environments

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Contemporary research literature within the field of youth talent development has unequivocally supported the notion for interactional or multi-dimensional perspectives, incorporating a number of influences under the concept of psychosocial competencies. Holt and Dunn (2004: *Journal of Applied Sport Psychology*, 16, 199–214) devised a grounded theory of the psychosocial competencies associated with success in elite adolescent level soccer.

The present study attempts to establish the transferability of Holt and Dunn's grounded theory of psychosocial competencies across participants in a talent development environment (TDE) in a different sport, namely athletics. Participants were recruited through a structured TDE in the sport of athletics, numbering six athletes with an age range of 14–19 years. Leading on from this, selected parents ($n=4$) and coaches ($n=2$) were interviewed utilising a similar interview structure to enable triangulation of opinions on the effective requirements of TDEs, and how this corresponds with and validates Holt and Dunn's grounded theory of psychosocial competencies across different sports. The sample of parents consisted of both mothers and fathers, to take into account findings by previous research indicating differences in type of social support provided by either parent. These data provided a triangulation as suggested by previous studies into social support processes.

The design of the semi-structured interviews conducted with athletes, parents, and coaches was directly modelled around the four identified psychosocial competencies of commitment, discipline, resilience, and social support. Collected and transcribed data were subjected to a process of thematic analysis and examined for emerging themes establishing the general dimensions of the four key identified psychosocial competencies. Constructing the methodology in such a manner allows the findings to be a truly applicable representation of the original grounded theory and its generalisability across other sports and TDEs. Results provided support in the four areas of commitment, discipline, resilience, and social support, and a coherent development of the original grounded theory is proposed. Sport-specific differences within TDEs are addressed, particularly factors relating to either team-based or individual sports.

The findings from participants are drawn together in relation to applied sport psychology implications, and the interactional nature of social support and athletes psychosocial competencies within TDEs. Directions for further research within the area are suggested.

SPSP2-36

Developmental differences in the impacts of motivational climates created by coaches, parents and peers

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Inconsistency in the assessment of motivational climates created by coaches, parents, and peers has created difficulties in comparing the relative influence of these significant others on athletes' experiences (Duda & Balaguer, 2007: In *Social psychology in sport*, edited by S. Jowett & D. Lavallee. Champaign, IL: Human Kinetics). To address this research gap, the purposes of this study were to a) develop an instrument (Cross Motivational Climate in Sport Questionnaire; CMCSQ) to assess the relative influence of perceived motivational climates created by coach, parents, and peers, and b) to compare the relative influence of these significant others on child and adolescent athletes' motivational outcomes (self-rated effort, enjoyment, competence, and competitive trait anxiety).

Questionnaire data were collected from 408 youth swimmers (Mean age = 12.48 years, $s = 2.96$). The sample included swimmers who had received regular training in the swimming clubs or school teams for one to five years (Mean = 3.36 years, $s = 2.53$). They were local-born Chinese whose mother language was Cantonese. Participants completed the questionnaire during a break in a competition or before a training session. Exploratory factor analysis and confirmatory factor analysis were employed to examine the factor structure of CMCSQ, and multi-group structural equation modelling was conducted to examine the invariance of the impacts of motivational climates between child and adolescent samples.

Exploratory factor analysis with 97 swimmers (mean age = 13.29 years, $s = .76$) suggested that the CMCSQ consisted of two factors (task involving climate and ego punishment climate). Confirmatory factor analysis in separate samples of 184 children (Aged 9–12 years) and 97 adolescents (Age = 15–18 years) swimmers also revealed good fit to this two-factor model (Table I). Results of multi-group

structural equation modelling analyses generally supported our hypothesis regarding the primary importance of parents in childhood, and peers in adolescence. Compared with athletes in the other age group, the influences of mother-created climates were stronger in childhood, and the influences of peer-created climates were stronger in adolescence. Coach-created climates were more influential for athletes' effort and enjoyment in childhood and were more influential for athletes' competence in adolescence.

The results suggested that age appears to moderate the impact of significant others on young athletes' sport experiences and that interventions might be most effective when certain socialising agents are targeted according to the age of the athletes involved.

SPSP2-37

In-match heart rate responses of bowlers in elite cricket

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Despite the sports global presence there is limited physiological research completed within elite cricket, specifically related to in-match data. An increased variety of competitions in cricket means in-match physiological player information may be beneficial to understand and enhance performance. The aim of this study was to assess heart rate responses during an elite cricket match.

Local institutional ethics approved research at an elite one-day match. A fast-bowler (age 27 years) and slow-bowler (age 30 years) volunteered to participate. Heart rate data were collected using the Polar Performance Heart Rate Team system (v4.00, Polar, Finland). Identification of in-match bowling spells, and fielding, was determined by synchronisation between the system and official club scorers. Data points prior to five heart rate increments and decrements were deemed the start and end of a bowling spell, respectively. Data were presented as mean \pm one standard deviation, analysed using independent t tests, with statistical significance accepted as $P < 0.05$.

Results (Table I and II) show bowlers elicited different heart rate related intensities while bowling and fielding. There was a significant difference between heart rate responses of fast and slow bowlers ($P < 0.001$), and also between fielding pre to post bowling ($P < 0.001$).

This novel study identifies in-match heart rate responses between different types of bowlers. Findings highlight an increased heart rate in bowlers

TABLE I.

Endogenous variable	Exogenous variables *age diff. $p < .05$	Path estimates * $p < .05$	
		Children	Adolescent
Effort	Coach task	.40*	.06
	Coach ego*	.13	-.23
	Father task	-.18	-.16
	Father ego	.28	.38*
	Mother task*	.53*	.10
	Mother ego	-.41	-.03
	Peer task*	.14	.63*
Enjoyment	Peer ego	.04	-.10
	Coach task*	.32*	.18
	Coach ego	.13	-.15
	Father task	.00	-.03
	Father ego	.16	.49*
	Mother task*	.35*	.02
	Mother ego	-.35*	.02
Competence	Peer task*	-.35	-.37
	Peer ego	.12	.44*
	Coach task	.12	.40*
	Coach ego*	.01	-.53*
	Father task	-.00	.20
	Father ego	.31	.13
	Mother task*	.33*	-.49*
Anxiety	Mother ego	-.17	.08
	Peer task	.04	.31*
	Peer ego*	.07	.43*
	Coach task	.20	-.20
	Coach ego	.24	.22
	Father task	.30	-.13
	Father ego	-.28	.03
	Mother task*	-.09	-.41*
	Mother ego	.38	-.18
	Peer task	-.26*	.03
	Peer ego	.38*	.17

Table I. In-match heart rate response when bowling.

Participants	Bowling spell (mins ⁻¹)	Number of overs	Heart rate _{max} (beats · min ⁻¹)	Heart rate _{min} (beats · min ⁻¹)	Heart rate _{mean} (beats · min ⁻¹)
Fast-bowler	47.40	6	173	81	137.8 ± 19.3
	18.00	2	170	93	130.9 ± 19.2
Slow-bowler	56.55	8	159	96	131.2 ± 12.0

Table II. In-match heart rate response when fielding pre and post of main bowling spell.

Participants	Bowling spell (mins ⁻¹)	Fielding	Heart rate _{max} (beats · min ⁻¹)	Heart rate _{min} (beats · min ⁻¹)	Heart rate _{mean} (beats · min ⁻¹)
Fast-bowler	55.30	Pre	145	65	90.2 ± 13.5
	39.05	Post	141	81	109.8 ± 10.5
Slow-bowler	63.40	Pre	139	84	111.9 ± 9.7
	38.15	Post	139	92	115.5 ± 10.4

when fielding post-bowling that could relate to accumulated fatigue post-bowling and issues of in-match decision making, which could be useful for coaches and associated tactical play. The study may also have useful implications for player workload monitoring and associated injury prevention during a game.

SPSP2-38

The effects of a video-aided imagery intervention upon collective efficacy in an international paralympic wheelchair basketball team

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Bandura (1997: *Self-efficacy: The exercise of control*. New York: Freeman) suggested that collective efficacy is important for team performance because it can influence a team's collective effort, their persistence in tough situations or defeat and is a characteristic often observed in successful teams. However, to date, little research has examined potential interventions that can be used to increase perceptions of collective efficacy in sports teams. Therefore, given that collective efficacy and self-efficacy share similar antecedents (e.g. imaginal experiences; Bandura, 1997), imaging team performances is likely to enhance feelings of collective efficacy. While the effects of imagery interventions in sporting contexts have been examined extensively, only limited research has considered imagery's influence on group factors that affect team

performance, such as collective efficacy (Munroe-Chandler & Hall, 2004; *Imagination, Cognition, and Personality*, 24, 51–67; Shearer *et al.*, 2007: *Journal of Sports Science and Medicine*, 6, 180–187).

A multiple baseline across-groups design was used to examine the effects of an imagery intervention on perceptions of collective efficacy. Members ($n = 10$) from an international wheelchair basketball team were separated into three intervention groups based on geographical location (South, Midlands, and North). Following a staggered baseline period, each group completed a four-week, video-aided, motivational general-mastery (MG-M) type imagery programme with team content. Collective efficacy was measured weekly via the Collective Efficacy Inventory (Callow *et al.*, 2004: *Journal of Sports Sciences*, 22, 301–302) and a wheelchair basketball-specific inventory designed for the study. To further assess the efficacy of the intervention, a four-item social validation questionnaire was used based on the measures adopted by Ming and Martin (1996: *The Sport Psychologist*, 10, 227–238). All measures were completed online as part of each participant's training records.

Collective efficacy increased for the South group and became more consistent for the Midlands group. No changes were reported for the North group. Social validation measures indicated potential mechanisms via imagery effects on individual perceptions of self-efficacy and then collective efficacy. The results provide partial support for the use of MG-M type imagery interventions to enhance both individual and team perceptions of collective efficacy in elite wheelchair basketball. Given the inconclusive findings, future research should further examine the effects of imagery on collective efficacy, before it is recommended as a suitable intervention for team sports.

SPSP2-39**Peak performance music videos as a tool for inducing arousal?**

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Recent advances in technology have led to an increase in the use of video in sport; with application to post-match analysis, skill breakdown, feedback and peak performance music videos (PPMV), whereby athletes' best performances are edited together to an appropriate music track to enhance performance (Templin *et al.*, 1995: *The Sport Psychologist*, 9, 41–50). PPMVs have been shown to increase motivation and self-confidence (Halliwell, 1990: *The Sport Psychologist*, 4, 369–377) but have received no research focusing on preparatory arousal, the most effective technique to enhance performance in sports requiring muscular force production (Tod *et al.*, 2003: *Sports Medicine*, 33, 47–58). The present study aims to examine whether PPMVs have an affect on arousal levels, measured using both psychological and physiological responses; which are said to be less influenced by voluntary control and less prone to subjective valuations (Bradley *et al.*, 2001: *Emotion*, 1, 300–319).

Following institutional ethics approval six collegiate athlete's (Male, $n=3$, Female, $n=3$, mean 22.14, $s=1.95$) took part in a single experimental session where physiological (heart rate, systolic blood pressure, diastolic blood pressure, galvanic skin response, breathing frequency and tidal volume) and psychological (the Affect Grid), responses to a control (blank screen), neutral (scientific documentary) and the experimental video (PPMV) were measured. Individual PPMV's were created from athlete's top performances over an 8 month filming period, during the competitive season, and were edited to an arousing music track selected by the participants. A well known athletics commentator provided commentary to add to the arousal inducing properties of the video.

A repeated measures multivariate analysis of variance (MANOVA) revealed significant main effects of video condition on arousal ($F_{2,10}=22.75$, $P<0.001$, effect size $\eta^2=0.82$), breathing frequency ($F_{2,10}=15.73$, $P<0.01$, effect size $\eta^2=0.76$) and systolic blood pressure ($F_{2,10}=5.91$, $P<0.05$, effect size $\eta^2=0.54$).

These findings support previous research (Halliwell, 1990: *The Sport Psychologist*, 4, 369–377), which found PPMVs to be a useful performance

enhancement tool. PPMVs may be of value when attempting to increase an athlete's arousal levels, as a preparatory arousal technique or part of a pre-performance routine. Future research should focus on the individual components within a PPMV (images, music and commentary), to further our understanding of this useful pre-performance intervention.

SPSP2-40**Effects of self-talk on attentional focus**

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Instructional self-talk (ST) has consistently been found to facilitate performance in tasks requiring fine motor movements. Nevertheless, a paucity of research exists regarding likely functions through which instructional ST affects performance (Hatzigeorgiadis, 2006: *Hellenic Journal of Psychology*, 3, 164–175). It has been proposed that ST may facilitate concentration; however it has yet to be established whether ST can be used to direct attentional focus. Pilot data collected as part of the present study implied that ST strategies were not effective in controlling the direction of attentional focus in skilled golfers in a within-subject design. Therefore the purpose of the present study was to investigate whether ST could be used to manipulate the direction of attentional focus in novice golfers using a between-group study design.

Thirty-six novice golfers (Age mean = 20.06, $s=1.84$ years) were randomly assigned to one of three ST groups respectively designed to generate an internal, proximal external or distal external focus of attention as conceptualized by Wulf and Shea (2002: *Psychonomic Bulletin and Review*, 9, 185–211). Participants completed four blocks of 15 pitch shots with an overt ST intervention introduced after the second block of baseline trials. Questionnaires which were completed at the end of blocks two, three and four assessed each of the three attentional foci. Three separate two-way (3×3) mixed-model ANOVAs were used to examine main effects and interactions between ST groups and blocks.

Each omnibus analysis revealed a significant main effect for group and block as well as a significant interaction ($P<0.05$). One-way ANOVA follow-up tests were conducted to better understand the shape of the interactions. Overall, results were consistent with the view that ST was effective in manipulating direction of attentional focus. For example, the

internal ST group reported focusing their attention internally to a greater extent than either external foci.

Findings offer support for the efficacy of ST strategies in manipulating the direction of attentional focus in novice golfers. This is considered particularly important given the consistent learning benefits associated with external attentional foci. However, further investigation is required to determine whether these ST strategies are effective for skilled golfers who may have acquired a disposition to utilise an internal focus of attention during task execution.

SPSP2-42

The use of podcasting in the delivery of unsupervised athletic training sessions

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Unsupervised sessions are an unavoidable occurrence for coaches, presenting a difficult task when trying to provide support to athletes (Kovacs *et al.*, 2008: *British Journal of Sports Medicine*, 41, 705–710) and they have received relatively little research interest (Coutts *et al.*, 2004: *Journal of Strength and Conditioning Research*, 18, 316–328). An emerging teaching resource in Education and Medicine is podcasting, which has been shown to facilitate and supplement learning (Copley, 2007: *Innovation in Education and Teaching International*, 44, 387–399). It can be used to broadcast any essential information and offers a practical solution for coaches. The present study aims to investigate the application and suitability of using podcasting as a coaching tool to support athletes when training independently during conditioning sessions.

Following institutional ethics approval, 15 athletes (Male, $n = 14$, Female, $n = 1$, Age mean 22, $s = 3.5$ years) from a variety of disciplines (decathlon $n = 9$, hurdles $n = 3$, javelin $n = 2$ and long jump $n = 1$) completed six counterbalanced training sessions: two supervised, two unsupervised and two podcasted (podcasts recorded by coach). Following completion of the sessions, participants reported their views on the podcast using a questionnaire. Follow-up interviews were then conducted to expand on the information generated from the questionnaires.

Content analysis of the interviews and questionnaires indicated that supervised sessions were the preferred choice of training, because of the input from, and interaction with, the coach. The podcast sessions were also preferred to the unsupervised sessions. Podcasts were viewed as easy to use, convenient and motivating. The coach's voice

offered a sense of familiarity to the unsupervised sessions and gave the feeling that the coach was present. Limitations included a lack of motivation when training alone, not being able to access the podcast and discomfort when using headphones.

The current study supports findings from the Education literature in that the use of podcasting offers a useful support tool in conjunction with traditional methods of teaching (Copley, 2007: *Innovation in Education and Teaching International*, 44, 387–399). The results suggest that podcasting may assist athletes during unsupervised sessions and may also increase attendance to such sessions. Future research should focus on why unsupervised training sessions are so poorly attended, so that we may better understand the psychological barriers athletes face when training alone.

SPSP2-43

Stress in elite sports coaching: Exploring responses to and consequences of stress

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Existing literature demonstrates there is a developing knowledge base on causes of stress in coaching (Frey, 2007: *The Sport Psychologist*, 21, 38–57). However, little research has focused on the impact of this stress on coaches. Therefore, as part of a wider investigation aimed at developing a more complete understanding of coaches' stress experiences, the present study explored responses to and consequences of stress for elite UK sports coaches.

With institutional ethics approval, six male and six female elite coaches, with experience of coaching at international competitions, participated in in-depth interviews. Coaches were asked to recall a particularly stressful time or incident in their career and interview questions were based on the consequences of stress and coaches' coping strategies. Transcribed interviews were inductively content analysed. For data trustworthiness, analyst triangulation (Patton, 2002: *Qualitative research and evaluation methods* (3rd edn.). Thousand Oaks, CA: Sage) was used to identify raw data responses and emergent themes.

Findings indicated that coaches perceived their stress to influence athletes' behaviour and performance. For example, coaches suggested that their behaviour under stress could have direct (miscommunication) and indirect (less time spent with athletes) effects. Coaches also indicated that they

could lose confidence and motivation as a result of stress. However, one theme indicated that coaches also highlighted positive consequences of experiencing stress, e.g. working harder and clear thinking. In the case of coping responses, "Positive Psychological Skills" was a dominant theme to emerge. Specifically, typical coping responses included positive thinking and thought-control strategies.

Findings of the present study support those of Thelwell *et al.* (2008: *The Sport Psychologist*, 22(1), 38–53) who reported that elite coaches used a range of psychological skills across situations that occur in their coaching roles. A systematic programme of psychological skills training could help elite coaches alleviate some of the negative stress responses that they feel can adversely affect their athletes. Since coaches perceived that their responses to stress could, in turn, influence their athletes' performance, future research exploring this relationship is warranted.

SPSP2-44

The effects of different judging styles on technique selection of elite Thai and UK Muay Thai competitors

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Anecdotal evidence from sports such as international amateur boxing suggests that changes in the criteria used to judge a sport, over time, influences the pattern of techniques used. However, no published studies to date have examined this. In Muay Thai differences in application of judging criteria have been found between Thai-trained judges and UK-trained judges (Myers, 2007: *Journal of Sports Sciences*, 25(3): 235–369). The aim of this study was to identify if differences in criteria application results in quantifiable differences in technique selection and application between elite UK and Thai MuayThai fighters using notational analysis.

Notational analysis was conducted on 16 fights involving UK fighters ($N=16$) and Thai fighters ($N=16$). Performance aspects that were recorded included: type of technique used, the target, the effect of the technique, balance before and after delivery and distancing. A Friedman's ANOVA suggested that the Thai fighters were a homogeneous group using a similar pattern of techniques ($P=0.14589$) but that the UK fighters were not ($P=0.00277$). Chi square analysis suggested statistically significant differences in a number of

qualitative aspects of technique delivery including balance ($P < 0.0001$) and technique effect ($p < 0.0001$). The attack profile of the Thai fighters comprised of 55.72% ($f=1106$, Mean = 69.13 ± 5.98) kicking techniques, where the UK group used kicks in 41.34% ($f=637$, Mean = 39.81 ± 22.12) of their attacks. UK fighters used punching in 27.97% ($f=431$) of their attacks compared to 14.56% ($f=289$) used by the Thai fighters. Differences were also found in the target of attacks with 84.33% ($f=1184$) of kicks and knees delivered by the Thai fighters aimed to the head and body compared to 71.02% ($f=549$) of UK fighters.

The reason for differences in homogeneity between groups may be accounted for by the fact that fights in Thailand are only judged by Thai-trained judges; in the UK both Thai-trained and UK-trained officials are used. Previous research suggested that Thai-trained judges considered kicks and knee strikes to the body more important than punches, where UK-trained judges considered punches, kicks and knees to be of equal value. This appears to be reflected in the types of attacks used by the respective groups. Thai-trained judges regarded balance as important but UK-trained judges did not, this again is reflected in the differences found.

Findings highlight the possibility that technique use is influenced by the application of judging criteria and needs to be considered in judge education.

SPSP2-45

The influence of progression feedback and self-belief on 20 km cycling time-trial performance

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The Central Governor Model suggests efferent control of skeletal muscles during exercise stems from the central integration of peripheral afferent feedback with various endogenous and exogenous reference signals. This study investigated whether pre-conditioned performance beliefs (an endogenous reference signal) can influence 20 km cycling time-trial (TT) performance.

A between- and within-participants experimental design was used. Thirty-one male cyclists (Age mean 34.3, $s=7.4$ years; height mean 177.5, $s=6.1$ cm; body mass mean 78.3, $s=8.7$ kg) performed four separate TT as fast as possible using their own bike

on a calibrated Computrainer™ (RacerMate, Seattle). All participants (within-participants factor) performed two familiarisation TT (TT1 and TT2), a blind TT with no performance feedback (TT3) and a TT with continuous feedback of power, speed and distance (TT4). Participants were randomly allocated to familiarization TT where different feedback methods were used (between-participants factor) involving either no performance feedback ($n=10$), accurate power, speed and distance feedback ($n=11$) or false power, speed and distance feedback showing values 5% greater than actual performance ($n=10$). False feedback was used to evoke confident beliefs in ambitious performance targets. Participants provided written informed consent to procedures that were conducted in accordance with the Declaration of Helsinki and approved by a local ethics committee.

Trial-by-condition interactions were found for cadence, $F(6,63)=2.8$, $P<0.05$, power, $F(6,69)=2.4$, $P<0.05$ and speed, $F(6,69)=2.6$, $P<0.05$. Post-hoc comparisons were made between TT2 (familiarized performance) and TT4 using paired-samples t tests. The blind group showed an increase in average cadence, $t(9)=1.9$, $P<0.05$, effect size $\eta^2=0.29$, average power, $t(9)=2.5$, $P<0.05$, effect size $\eta^2=0.41$, and average speed, $t(9)=2.4$, $P<0.05$, effect size $\eta^2=0.39$. The accurate feedback group showed no change in average cadence, speed or power. The false feedback group showed an increase in average cadence, $t(9)=2.3$, $P<0.05$, effect size $\eta^2=0.37$ but no change in average power or speed.

Results from the blind group show that the absence of performance feedback causes conservative pacing. Lower cadence among the false feedback group (caused by attempting a bigger gear) indicates increased conscious effort to accomplish previously conditioned performance norms. Since there was no change in average power or speed among the false feedback group it is concluded that ambitious performance beliefs might provoke changes in conscious pacing strategy but do not necessarily result in improved performance. This is an indication that conscious pacing efforts cannot supersede the central governor's efferent control ceilings irrespective of any associated ambitious performance belief.

SPSP2-46

Stress in elite sports coaching: identifying stressors

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Coaching is an inherently stressful occupation (Kelley & Gill, 1993: *Research Quarterly for Exercise and Sport*, 64(1), 94–102), yet despite coaches' pivotal role in athletic performance, their experiences of stress have not been studied in depth. Lazarus' transactional theory of stress (1966: *Psychological stress and the coping process*. New York: McGraw-Hill) has been adopted in sport psychology literature and highlights the dynamic relationship between environmental demands (stressors) and individuals' psychological resources for dealing with them (e.g. coping ability). Stress responses (strain) result from a perceived imbalance between demands and resources. As part of a wider investigation into the stress experiences of elite coaches, the purpose of this study was to identify stressors encountered by elite coaches in the UK.

With institutional ethics approval, six male and six female elite coaches with experience of international competition were interviewed about stressors they experienced during their careers. In-depth interviews were used as the method of data collection. To ensure credible data, transcribed interviews were inductively content analysed and consensus was reached on all themes by three independent researchers.

Findings indicated that "Conflict" and "Pressure and Expectation" were two of the largest higher-order themes to emerge. The theme "Conflict" indicated that organisational factors, including a lack of cohesion in the camp and collaborating with other organisations, were salient stressors for coaches. In "Pressure and Expectation", self-imposed and outcome pressures were two lower-order themes. However, the majority of coaches felt that interactions with athletes were the "most stressful" aspects of their jobs.

The findings of the present study support Frey's (2007: *The Sport Psychologist*, 21, 38–57) assertion that the coach-athlete relationship is mutually stressful. Coaches could benefit from developing communication skills that would enable them to function effectively as part of a wider organisational "team". As coaches indicated that pressure and expectation were stressful and that their role was often isolated, psychological skills training and the development of mental toughness might help them cope with the demands of coaching. Sport psychology practitioners should also consider developing skills to help coaches deal with a range of concerns beyond those associated with the athletic arena. Future research should also consider the impact of stressors and the development of possible coping strategies specific for elite coaches.

SPSP2-47**Psycho-physiological responses of team and individual performers during task and ego-oriented competition**

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Modern sport has the potential to induce high levels of physiological and psychological stress in athletes. Despite this, it has been suggested that performing as part of team can reduce the stress associated with competitive performance (Terry *et al.*, 1996: *Perceptual Motor Skills*, 82, 595–603). Their study used 100 tennis players who took part in both singles and doubles matches. The results showed that anxiety measured by CSAI-2, was lower while part of a team.

Following ethical approval, 32 participants (27 males mean age 22.41, $s=3.79$ years and 5 females mean age 20.8, $s=1.10$ years) volunteered and took part in a repeated measures design which involved participants partaking in table football matches lasting 5 minutes in length. Measurements of heart rate (Polar S610i, Polar, Kempele, Finland), heart rate variability and forearm skin temperature (Digitec thermister thermometer 5831, Digitec Corporation, Marion, USA) were recorded throughout, as well blood pressure (Omton HEM-907, Omron Health Care, Kyoto, Japan) at the beginning and end of each trial. All participants performed under the following four conditions: individual and task-oriented, individual and ego-oriented, team and task-oriented and team and ego-oriented, the order of which was randomised. The data gathered by this process was analysed using a two (individual *versus* team) by two (task *versus* ego) ANOVA or two (individual *versus* team) by two (task *versus* ego) by three (before, during and after) ANOVA. Heart rate variability was significantly different between individual and team conditions ($F_{1,24}=6.20$, $P=0.02$, partial $\eta^2=0.25$) with heart rate variability being lower during the individual conditions, indicating higher levels of anxiety. Furthermore, heart rate variability was also significantly different between the task and ego-oriented conditions ($F_{1,24}=53.01$, $P<0.001$, partial $\eta^2=0.69$) with heart rate variability being lower during the individual conditions. Also, significant differences were evident in relation to skin temperature between individual and team conditions ($F_{1,28}=4.19$, $P=0.05$, partial $\eta^2=0.13$) with skin temperature being lower whilst performing individually, which is an indicator of increased

stress (Herd, 1991: *Physiological Reviews*, 71, 305–331).

These results indicate that being part of a team reduces physiological stress during competition. Furthermore, this study indicates that task-oriented competition is less stressful than ego-oriented competition. Based on this finding, coaches could emphasise task-based goals to reduce stress in competitive situations.

SPSP2-48**A qualitative study of organisational stressors in non-elite performers from individual and team sports**

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Organisational stressors have been defined as “the environmental demands (i.e. stimuli) associated primarily and directly with the organisation within which an individual is operating” (Fletcher, Hanton, & Mellalieu, 2006: In *Literature reviews in sport psychology*, edited by S. Hanton & S. D. Mellalieu, p. 329. Hauppauge, NY: Nova Science). Whilst previous research has identified these types of stressors in elite sport performers, there remains a need to investigate the organisational stress experienced in athletes of lower skill levels (Fletcher & Hanton, 2003: *The Sport Psychologist*, 17, 175–195). Therefore, the present study explored the content of organisational stressors in non-elite performers. A secondary purpose was to compare the quantity of organisational stressors experienced by athletes in individual with athletes in team sports.

Following ethical approval, 12 club and county performers (age mean = 21.17 years, $s=1.47$) from individual ($n=6$) and team sports ($n=6$) were interviewed regarding their experiences of organisational stress. Content analysis of the data involved categorising the demands associated primarily and directly with the sport organisation into one of the following five dimensions: factors intrinsic to the sport; roles in the sport organization; sport relationships and interpersonal demands; athletic career and performance development issues; and organisational structure and climate of the sport. Of the organisational stressors that were identified (#OS = 165), performers in team sports recalled more demands (#TSOS = 134) than those in individual sports (#ISOS = 84) across a number of higher-order themes including: training issues; role conflict; poor team cohesion; lack of social support; issues with selection; injuries; and management issues.

A comparison with previous research indicates that non-elite performers recall similar organisational stressors to that of elite performers (e.g. training issues, role conflict, selection issues). However for the most part, non-elite athletes appear to experience less demands than elite athletes. It is recommended that sport psychologists employ stress management techniques to advise non-elite performers how best to manage the specific organisational stressors experienced. Such programmes could include performance profiling and team building exercises designed to encourage open communication channels and enhance team cohesion within the sport organisation.

SPSP2-49

Stressed out shrinks: Sport psychologists' experiences of organisational stressors in academic and practical jobs

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This study extends recent research investigating organizational stress in competitive sport. Whilst previous work has focussed on the stress experienced by elite performers, Fletcher, Hanton and Mellalieu (2006: In *Literature reviews in sport psychology*, edited by S. Hanton & S. D. Mellalieu. Hauppauge, NY: Nova Science) observed that research is still required to explore the stressors placed upon support team staff (e.g. psychologists, physiologists, biomechanists). Indeed, sports scientists often adopt multiple roles (e.g. consultant, educator, etc) in their careers and it is likely they encounter a wide variety of demands associated with their profession. The study reported here focuses on the experiences of sport psychologists and, more specifically, the organisational stressors they encounter in the course of their work. A secondary purpose was to compare the experiences of sport psychology academics with those of practitioners.

Following ethical approval, 12 full-time sport psychologists (six academic and six practitioners) were interviewed regarding their experiences of organisational stress within their jobs. Inductive and deductive content analyses involved categorising the demands associated primarily and directly with the organisation within which they operated under one of the following dimensions: factors intrinsic to sport psychology; roles in the organisation; sport relationships and interpersonal demands; career and

performance development issues; and the organisational structure and climate of the profession.

Within these dimensions the specific stressors identified related to various aspects of the profession including: teaching; research; consultancy; workload and hours; lack of social support; career advancement; and income and funding. A comparative analysis revealed that academics encountered more demands relating to teaching, research, inadequate communication channels, and responsibility within the job, whereas practitioners encountered more demands relating to consultancy, presentation issues, and personalities within the job.

These findings suggest that sport psychologists experience numerous organisational stressors. Several of the higher-order themes that emerged appear to be similar to the workplace stressors identified previously in the occupational psychology literature (Sutherland & Cooper, 2000: *Strategic stress management: An organisational approach*. Basingstoke: Palgrave), with several new themes arising that appear more specific to the profession of sport psychology (e.g. research assessment exercise, media, ethics). From an applied perspective, sport psychologists are encouraged to "practice what they preach" and develop stress management strategies and interventions to deal with their idiographic stress experiences.

SPSP2-50

Effects of two different strategies on the awareness of, and motivation to change negative self-talk

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Self-talk (ST) logbooks and paperclip exercises have been advocated to raise athletes' awareness of negative ST (Zinsser, Bunker, & Williams, 2006: In *Applied sport psychology: Personal growth to peak performance*, edited by J. M. Williams. Boston: McGraw-Hill). Despite the appeal of these strategies little evidence exists supporting their efficacy. The present study examined the effects of these two strategies on both the awareness of the content (CONTENT) and use (USE) of negative ST as well as motivation to change negative ST (MOTIVATION).

Seventy-nine university athletes (Age mean 19.83, $s = 2.93$ years) completed a questionnaire measuring MOTIVATION, CONTENT, and USE. They were then assigned to one of three groups: a control, a logbook, and a paperclip group. All participants

performed three typical training sessions over a three-week period. The logbook group completed a ST logbook after each session. The paperclip group moved paperclips from one pocket to the other each time they used negative ST, and then recorded the number of paperclips used during each session. Upon completion of the training sessions, participants completed the questionnaire for a second time.

Internal consistency values for the dependent variables were acceptable and three single-factor ANCOVAs (using pre scores as a covariate) were conducted to analyse the data. Utilising this approach, no significant group differences emerged for MOTIVATION. However, a significant difference was revealed for CONTENT ($F_{2, 61} = 3.12$, $P < 0.05$, $\eta^2 = 0.09$). Follow-up tests failed to indicate where the significant differences lay, although inspection of the means indicated that the logbook appeared to have the greatest effect on CONTENT. Additionally, a significant group difference was found for USE ($F_{2, 61} = 5.17$, $P < 0.01$, $\eta^2 = 0.15$). Follow-up tests indicated that both intervention groups had significantly greater awareness of USE than the control group, although no differences between the intervention groups emerged.

The findings lend some support to the efficacy of logbook and paperclip based interventions as suitable strategies to aid athletes' awareness of negative ST. However, awareness strategies involving logbooks are less intrusive and potentially less disruptive to athletes' practice sessions. Furthermore, it would seem that awareness intervention strategies alone do not influence individuals' motivation to alter their use of negative ST.

HBIP3-01

Weekend steps, but not weekday steps, are associated with BMI in British children

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A pedometer determined threshold of 12,000 steps per day for girls and 15,000 steps per day for boys has been associated with normal weight and has subsequently been recommended as the cut-off to prevent overweight in children (Tudor-Locke *et al.*, 2004: *Preventive Medicine*, 38, 857–867). Recently, Eisenmann *et al.* (2007: *International Journal of Obesity*, 31, 1179–1182) suggested that children who did not achieve these cut-points were more likely to be classified as overweight or obese. However, it appears

that little attention has been paid to the day-to-day variability in physical activity in children and its subsequent association with weight status (Wickel *et al.*, 2007: *American Journal of Human Biology*, 19: 537–543). The aim of this study was to examine the association between weight status and physical activity in British children.

Following ethical approval and informed consent, 496 children (215 male and 281 female) aged 8–14 years wore a sealed pedometer for 2 weekend days and 2 week days. Height and mass were measured using a Seca Stadiometer and weighing scales (Seca Instruments Ltd, Germany) from which body mass index was calculated. Overweight/obesity was determined using International Obesity Task Force Cut-Offs (Cole *et al.*, 2000: *British Medical Journal*, 320, 1240–1243). A two way (the two factors being gender and above or below the Tudor-Locke threshold) analysis of covariance was used to examine the data with BMI as the dependant variable and age, average weekend steps and average weekday steps as covariates.

Results indicated that boys had significantly greater BMI than girls ($F_{1, 494} = 16.3$, $P = 0.001$), that as children got older physical activity declined ($F_{1, 494} = 46.4$, $P = 0.001$) and that higher values for average weekend steps were associated with lower BMI values ($F_{1, 494} = 10.0$, $P = 0.002$). Conversely, the scores for average weekday steps were not significantly associated with BMI ($P < 0.05$). Likewise, there was no difference in BMI identified by the cut-off points advocated by Tudor-Locke *et al.* (2004: *Preventive Medicine*, 38, 857–867).

These findings appear to agree with assertions made by Wickel *et al.* (2007: *American Journal of Human Biology*, 19: 537–543) regarding the day-to-day variability of pedometer counts in children. Weekend steps appear to be more strongly related to children's weight status than weekday step counts. Therefore, attempts to modify children's weight status through physical activity may be better placed at the weekends than weekdays.

HBIP3-02

Direct evidence to demonstrate that running causes spinal shrinkage within the lumbar vertebral region

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Ambulatory movement has been demonstrated to cause a loss of stature, as measured by stadiometry

(Van Deursen *et al.*, 2005: *Clinical Biomechanics*, 20, 547–550). This loss in stature is often termed spinal shrinkage as it is thought to reflect compression of the intra-vertebral discs, especially within the lumbar vertebrae. However, no direct evidence exists to show that exercise-induced spinal shrinkage is associated with a loss of height within the lumbar region. This study aimed to quantify the effects of moderate intensity treadmill running on lumbar region height and spinal shrinkage.

Eight healthy active males (Mass mean 73.6, $s = 16.0$ kg, Height mean 1.77, $s = 0.06$ m; Body composition mean 17.1, $s = 4.4$ %BF) volunteered and gave informed consent to participate in the study, which received prior ethical approval. During preliminary testing, all participants were fully familiarised with the measurement of stature and completed a progressive treadmill run to volitional exhaustion. On a subsequent occasion, stature was measured, according to the methods described in the International Standards for Anthropometric Assessment (ISAK, 2001) using a Portable Stadiometer (Holtain, UK), and lumbar x-ray radiographs were taken from the anterior aspect immediately before and following 30 min of treadmill running at 70% heart rate reserve.

Treadmill running at 70% heart rate reserve caused significant reductions in stature of 8.6 ± 1.0 mm ($P < 0.001$), representing spinal shrinkages of $0.5 \pm 0.1\%$ initial stature. Following exercise, height of the lumbar vertebral regional (superior surface of L1 to the inferior surface of L5) was reduced by 4.4 ± 0.8 mm ($P < 0.001$), which represented a loss of $2.4 \pm 0.5\%$ height within this region. Furthermore, exercise-induced shrinkage in the lumbar vertebral region accounted for $51 \pm 9\%$ of the total spinal shrinkage.

These findings provide direct evidence to confirm that moderate intensity running causes vertical compression in the lumbar vertebral region. Shrinkage in the lumbar region accounted for approximately one half of total spinal shrinkage, which probably reflects the large intradiscal pressures that have been estimated to act on this region of the vertebral column during ambulatory activities.

HBIP3-03

Physical activity and anthropometric characteristics of children with and without learning disabilities

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Melville *et al.* (2007: *Obesity Reviews*, 8, 223–230) highlighted that adults with learning disabilities (LD) are more obese than their non-LD adult peers due to much reduced physical activity (PA) levels. It is not clear from existing literature at what age this increased obesity rate occurs. Little evidence exists on these variables in LD children.

The purpose of this study was to investigate body mass index (BMI), percentage body fat (%BF) and PA levels in children with LD compared with pair-matched children without LD.

With institutional ethics approval, 16 children with learning disabilities and 16 age and gender-matched children without LD participated in the study (Male, $n = 12$, age mean 11.8, $s = 1.9$ years; Female, $n = 4$, age mean 9.5, $s = 1$). BMI was calculated from height (Leicester Height Measure) and weight (SECA Digital scales LS880) measurements. Triceps and subscapular skin-fold thickness was measured (Harpender calipers) and Lohman equation used to calculate %BF. PA was measured over 5 days using GT1M accelerometers (Acti-Graph, USA).

Mean $\pm s$ values are given for each variable. Two-sample *t* tests determined differences between LD and controls for each variable. Table I shows no difference was found in BMI between the groups ($P = 0.193$). Children with LD had significantly higher sum of skinfold thickness ($P = 0.02$) thus %BF ($P = 0.028$), than the controls and spent significantly more time sedentary ($P = 0.00$) and less time in moderate-vigorous PA (MVPA) (7.8 *versus* 36.0 mins) ($P = 0.00$).

This study indicates that children with LD have greater body fat, are even more sedentary and spend significantly less time in MVPA compared with non-LD children, who are already mostly sedentary. Future work must identify reasons for this difference in activity and design interventions to combat it.

Table I. Characteristics (mean, $\pm s$) for children with learning disabilities (LD) and children without (Control).

	LD	Control
Weight (kg)	43.6 ± 17.7	42.7 ± 12.0
Height (m)	1.4 ± 0.1	1.5 ± 0.1
BMI (kg/m ²)	20.4 ± 5.1	18.5 ± 3.0
BMI centile	66.9 ± 36.7	62.7 ± 29.1
[†] Σ Skinfold thickness (mm)	33.4 ± 17.6	21.2 ± 7.5
[†] Body fat (%)	27.3 ± 11.0	19.7 ± 6.0
[†] Volume Daily PA (counts \cdot min ⁻¹)	405.4 ± 228.4	793.7 ± 213.9
[†] Time spent sedentary (%)	85.5 ± 5.3	73.8 ± 6.0
[†] Time spent MVPA (%)	1.3 ± 1.8	8.6 ± 4.5

Note: [†]Significant difference between LD and control ($P < 0.05$).

HOTP3-04**Contraception, bone health and physical activity**

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Depot medroxyprogesterone acetate (DMPA) is a progesterone-only contraceptive, which has been found to adversely affect bone health (Curtis & Martins, 2006: *Contraception*, 73, 470–487). Current advice from the Committee on Safety of Medicine (2004) is to advocate weight-bearing exercise for DMPA users, yet no empirical research has been used to substantiate this advice. It is conceivable that exercise for DMPA users may contribute to, rather than prevent, the contraceptive-related loss in bone density, similar to the effects observed among oral contraceptive (OC) users (Weaver *et al.*, 2001: *Medicine and Science in Sports and Exercise*, 33, 873–880). The purpose of this cross-sectional, exploratory study was to examine the combined effect of physical activity and contraceptive use (including DMPA) on bone health.

Following University ethical approval, bone parameters of 46 females (mean age, 20.7, $s=1.9$ years; mean body mass index (BMI) 23.8, $s=3.4$ kg/m²), consisting of 27 OC users, eight DMPA users, and 11 controls (no contraception), were assessed using quantitative ultrasound of the *os calcis* (UBIS 5000). A Bone Loading History Questionnaire (BLHQ) (Dolan *et al.*, 2006: *Medicine and Science in Sports and Exercise*, 38, 1121–1131) was used to indicate physical activity undertaken with specific bone-loading properties. Mean values for Broadband Ultrasound Attenuation (BUA), corrected for age and BMI, differed significantly due to contraceptive type ($F_{45,2}=7.332$, $P=0.002$), but not for physical activity score ($F_{45,1}=2.908$, $P=0.10$); mean BUA was 61.4, $s=2.4$, 62.9, $s=3.7$ and 65.5, $s=3.3$ dB/MHz for DMPA users, OC users and controls, respectively. Using a median split of BLHQ score, participants were divided into low or high physical activity groups. Mean BUA of controls was higher for the high physical activity group compared to the low physical activity group (66.4, $s=1.5$ versus 64.7, $s=4.3$ dB/MHz), as anticipated, since physical activity, particularly of a high-impact nature, is known to be beneficial in increasing bone density in eumenorrhoeic women. For the contraceptive users, however, mean BUA for the high and low physical activity groups (62.2, $s=3.6$, and 63.7, $s=3.7$ dB/MHz, respectively) was similar. Physical activity, therefore, does not appear

to have a significant effect on bone health among contraceptive users, being neither detrimental nor beneficial. Further analysis of the data is warrant on a larger sample of females.

HOTP3-05**Activity levels of below-knee amputees**G. Codling¹, H. Dawes¹, K. Howells¹, E. Stoppard², & D. Hendeson-Slater²¹Oxford Brookes University and ²Oxford Centre of Enablement, UK

Participating in physical activities provides health and wellbeing benefits for all including those with cardiovascular pathology. A lack of physical activity is now considered to be one of the major risk factors for a number of diseases with high morbidity/mortality rates. Despite clinical reports of low mobility, to date we do not know how many steps amputees take in a day or what sort of physical activities they participate in. Determination of both physical activity participation and the number of steps taken by a sample of amputees will help inform the planning of suitable exercise interventions for this clinical population. Thus, the aim of the study was to measure the ambulatory mobility and physical activity participation of amputees wearing below-knee prostheses.

From a hospital list of a possible 696 below-knee amputees, 27, of which 21 were males and six were females; mean age: 62 ($s=11.8$) years were recruited. The study sample was homogeneous to the 696 possible below-knee amputees, regarding age, sex and cause of amputation (Independent t test and Pearson Chi-squared Goodness of fit test: $P > 0.05$). Participants were asked to complete the Physical Activity scale for the Elderly (PASE) and to wear a Step Activity Monitor (SAM) for 8 days to record step counts.

The participants' mean steps/day were 1842 ($s=1456$), (range: 14 to 5266.) The mean total PASE score was 127 ($s=88.54$) range: 5–385 The household sub-scale of the PASE was where the subject scored most highly with a mean score of 73.59 ($s=34.92$) (range: 0–136), followed by leisure score of 32.63 ($s=25.40$) (range: 0–95). The work sub-scale was where participants scored the lowest with a mean score of 20.77 ($s=53.41$). The Pearson correlation (1-tailed) between the SAM and PASE was (0.6, $P < 0.01$), leisure (0.6, $P < 0.01$) and household (0.5, $P < 0.01$).

This study confirms that patients wearing below-knee prostheses have lower step counts than

currently recommended (Bohannon, 2008: *Physical Therapy*, 87, 12) and that physical activity mainly occurs at home within their daily routine. Participation in leisure activities which are beneficial for health was uncommon. Our findings indicate general inactivity in this clinical group. Further research on a bigger sample may examine factors affecting activity levels in different clinical sub groups.

HOTP3-07

Percieved barriers to physical activity in individuals with progressive neurological conditions; a focus group and questionnaire study

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In spite of growing evidence that regular exercise may provide health and social benefits for people with neurological conditions, it is apparent that there are barriers to physical activity participation. Few studies have investigated barriers to participation in individuals with neurological conditions.

The purpose of this study was to determine the opinions of adults with neurological conditions on barriers to physical activity participation.

Following ethical approval from the University Research Ethics Committee, 24 individuals (Age: mean 54, $s=25$) with neurological conditions (muscular dystrophy $n=5$, multiple sclerosis $n=7$, motor neurone disease $n=6$, and Parkinson's disease $n=6$) gave formal consent to participate in condition specific focus groups. Focus group discussions were documented by three researchers and independently analysed. Themes that emerged were used to develop an eight item self-completed questionnaire, which explored barriers to participation.

A total of 115 questionnaires were distributed and 80 (70%) were completed. Age of responders in years ranged from 42 to 68, ($n=115$, Age: mean 55, $s=13$), 48 (60%) were women, 27 (33.75%) people had the diagnosis of multiple sclerosis, 30 (37.5%) muscular dystrophy, 13 (16.25%) Parkinson's disease, 10 (12.5%) "other" (stroke or motor neurone disease).

Half of the responders ($n=40$) reported the main barriers were; staff lack of condition specific knowledge, fitness professional's inadequate knowledge of suitable condition specific exercises and feelings of

embarrassment. One third ($n=26$) of responders cited concerns over cost, suitability of the environment, time constraints and lack of personal care support. Half the responders ($n=40$) wanted to exercise with people either with their condition or another disability.

These findings are in line with previous studies with individuals with physical disabilities; however, specifically addressing the training issues of fitness professionals to increase their knowledge of neurological conditions was one key area that was highlighted as needing improvement. People with neurological conditions enjoy participating in physical activity. If physical activity participation is to be encouraged within neurological populations, then barriers to participation need to be addressed.

HOTP3-08

Six months of pilates-based exercise in adult women improves the health-related quality of life and the life satisfaction

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The Pilates method is recognized to have numerous benefits on health and there are a few studies to support this statement. The purpose of this study was to determine the effects of Pilates-based mat exercise (PME) on health-related quality of life (HRQL) and life satisfaction (LS), important characteristics of psychological human development.

Sixty-three women (aged 25–55) were randomised into a control (CG) ($n=24$) (mean 40.3, $s=7.7$) and experimental (EG) ($n=39$) (mean 41.3, $s=6.7$) groups. The EG was enrolled in PME for 24-week, two times per week, 60-minutes per session. The Committee on Ethics (University of Évora approved the study. EQ-5D questionnaire and Satisfaction with Life Scale (SLS) were used to assess the HRQL and LS, respectively. The EQ-5D comprises five dimensions of health: Mobility (M), Self-care (SC), Usual activities (UA), Pain/Discomfort (PD) and Anxiety/Depression (AD). Furthermore, a visual analogue self-rating scale in which the best and worst imaginable health states score 100 and 0, respectively, measures the Health Status (HS). The SLS consists on five statements with a Likert's scale answer from strongly disagree to strongly agree. Each participant answered the questionnaires in a unique session, and the order application was the same at baseline, after 12 and 24 weeks.

The repeated measures ANOVA and Bonferroni were run in SPSS 15.0. For all tests the significant level was set at $P < 0.05$.

Statistically significant differences were found on HRQL, particularly on PD ($P=0.01$), between baseline and week 12 ($P=0.049$) and between baseline and week 24 ($P=0.003$), and on HS ($P=0.010$), between baseline and week 24 ($P=0.029$). There were no differences on M, SC, UA and AD, probably as the participants did not have limitations on these variables at baseline. In what concerns LS, there were significant differences ($P=0.002$), between week 12 and week 24 ($P=0.002$) and between baseline and week 24 ($P=0.049$).

This study demonstrated that the exposure of adult women to PME during 12 weeks, for two 60-minutes sessions per week was enough to decrease the PD. However, after 24 weeks the PD decreases even more. Additionally, adult women increased HS and LS. In conclusion, the results suggest after 12 weeks of PME, significant improvements attributable to practice effects found in PD and after 24 weeks in PD, HS and LS.

HOTP3-09

Self-optimisation of energy cost during human walking across altering gait

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Despite research examining minimal oxygen cost and self-optimisation under altered step times and lengths, to date, there is no data available where self-optimisation has been examined in this manner in simulated or actual pathological gait. Understanding if optimisation occurs in manipulated gait may inform strategies to reduce the effort of walking in individuals with lower limb dysfunction. We investigated energy cost in human walking under normal and right hip and knee immobilised gait in healthy participants.

Fourteen healthy male participants took part. Participants walked on a treadmill (Woodway, UK) at a range of speeds derived from their self-selected walking speed. Froude number (Fr) ($Fr = v^2/gxL$: v =velocity, g =acceleration due to gravity, L =leg length) was calculated for each individual at each speed. Calculation of Fr normalises speed for individual differences in leg length. Laboratory testing was carried out under standardised conditions as a continuous protocol, expired air being collected in Douglas bags during minutes 3–4 of each walking velocity. The steady state metabolic

energy consumption was calculated ($ml \cdot kg^{-1} \cdot min^{-1}$) and corresponding energy cost of walking calculated ($J \cdot kg^{-1} \cdot m^{-1}$) at each velocity. Within 1 week, eight of the 14 participants attended Test 2, which followed the same procedure and pre-test conditions as Test 1 with testing performed with their right leg immobilised using a hip and knee brace.

An altered metabolic demand was successfully achieved in Test 2 compared with Test 1. Repeated measures ANOVA found a significant within-subject difference in Fr and energy cost ($J \cdot kg^{-1} \cdot m^{-1}$) at different percentages of self-selected walking speed ($P < 0.05$). Minimum energy cost ($J \cdot kg^{-1} \cdot m^{-1}$) did not occur at self-selected walking speed in either Test 1 or Test 2, however, the size of the optimum walking cost:self-selected walking speed disparity was the same in both Tests, according to a paired t test ($P=0.36$).

SSWS occurred at a slower Fr than optimal energy cost with an equal disparity between optimal energy cost and self-selected walking speed in both walking conditions. We propose the underlying mechanism for optimisation is related to optimal energy cost and standard across normal and artificially constrained conditions in healthy participants. We now recommend further investigations with patient groups displaying lower limb dysfunction.

HPHP3-10

Validity and reliability of body composition measurement using the TANITA BC418-MA

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This investigation compared measurements of percentage body fat (%BF) by a novel bioelectrical impedance analysis (BIA) system, the TANITA BC418MA (TAN) with hydrostatic weighing (HW) and skinfold thickness (ST) (study 1). In addition the same-day test-retest reliability of the TAN system was assessed (study 2). For study 1, a sample of 28 male (age 24, $s=8$ years, height 1.76, $s=0.09$ m, body mass 75.4, $s=14.5$ kg) and 29 female (age 22, $s=6$ years, height 1.70, $s=0.10$ m, body mass 67.2, $s=10.7$ kg) participants were recruited. HW, TAN and ST were used to assess %BF, with the same experimenter completing all assessments in a counterbalanced order. In study 2, 24 males (age 38, $s=12$ years, height 1.79, $s=0.07$ m, mass 82.80, $s=13.59$ kg) and 28 females (age 45, $s=11$ years, height 1.65, $s=0.08$ m, mass 61.88, $s=10.46$ kg) had %BF

measured on two occasions using the TAN to establish the same-day test-retest reliability of the system. Results for study 1 indicated that TAN and ST recorded significantly different mean %BF when compared to HW, with %BF being overestimated by 1.68% using TAN and 1.49% using ST. Despite strong correlations between TAN and HW ($r=0.81$; $P<0.05$) there was relatively poor agreement between %BFs from TAN and HW ($\pm 9\%$), although the level of agreement between ST and HW was a little better ($\pm 8\%$). The same-day test-retest reliability of TAN was good, with no mean bias from test to test and excellent limits of agreement ($\pm <1\%$). In conclusion, the TANITA BC418MA is a reliable system, which has poor agreement with laboratory-based methods of assessment (HW). However it is on a par with assessment by skinfold thickness and provides a non-invasive alternative, which requires less operator training.

HPHP3-11

Differences in muscle activity of the rectus abdominis during exercises on and off a Swiss ball

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The Swiss ball has become a widely used mode of abdominal training in recreational and clinical settings. Its use has been justified on the basis that increased muscular demand is required to maintain postural stability although evidence supporting this is lacking (Marshall & Murphy, 2006: *Applied Physiology Nutrition and Metabolism*, 31, 376–383). Moreover, although muscle activity of the rectus abdominis (RA) has been explored, results from previous studies are contradictory and the majority of studies on this topic have not examined activity of both the upper (URA) and lower rectus abdominis (LRA) (Clark *et al.*, 2003: *Journal of Strength and Conditioning Research*, 17, 475–483). The aim of this study was to compare muscle activity of the URA and LRA during four commonly used abdominal exercises on and off a Swiss ball.

Following ethical approval and informed consent, seven male and seven female participants (Mean age $\pm s = 21.8 \pm 3.8$) performed four abdominal exercises (curl-up, Swiss ball curl-up, Swiss ball rollout, jackknife) in a randomised order. Muscle activity of the URA and LRA was recorded via an on-line, ME6000 EMG system (MEGA Electronics, LTD, Finland). Collected signals were expressed as

a relative percentage of a maximal voluntary isometric contraction (MVIC) performed for each muscle. A 2 (URA *versus* LRA) \times 4 (exercise) way repeated measures analysis of variance was used to examine differences in URA and LRA activity across exercises.

Results indicated a significant region by exercise interaction ($F_{3,39} = 6.52$, $P < 0.01$, partial $\eta^2 = 0.580$). Muscle activity of the URA was greater than LRA activity for the curl-up, Swiss ball curl-up and Swiss ball roll out. However, LRA activity was greater than URA activity during the jackknife. There was also a significant exercise main effect ($F_{3,39} = 30.78$, $P = 0.01$, partial $\eta^2 = .861$). Bonferroni multiple comparisons indicated that the muscle activity during the curl up was significantly lower than muscle activity during the Swiss ball curl-up ($P = 0.02$), jackknife ($P = 0.01$) and the Swiss ball rollout ($P = 0.01$).

Results of the present study indicate that muscle activity was greater when exercises were performed on a Swiss ball. This supports previous studies (Marshall & Murphy 2006: *Applied Physiology Nutrition and Metabolism*, 31, 376–383; Clark *et al.*, 2003: *Journal of Strength and Conditioning Research*, 17, 475–483). Furthermore, activity of the URA was greater than the LRA in all exercises other than the jackknife. Therefore, if increased activation of the LRA is the goal of an exercise or rehabilitation programme the jackknife exercise may be particularly useful.

HPHP3-12

Serum lipid responses to prolonged intermittent and continuous exercise in Type 1 diabetes patients

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An improvement in the blood lipid profile of Type 1 diabetes (T1DM) patients is one of the recommended benefits of physical training. Current advice given to patients regarding which exercise to perform is rather vague and when based on evidence uses results from studies employing mostly continuous exercise rather than intermittent activities (e.g. soccer, rugby, tennis). The aim of this study was to compare the lipid profile of T1DM following an acute bout of intermittent and continuous exercise.

With local ethics committee approval and informed consent 9 non-diabetic (ND) and 9 T1DM patients participated in this study. Physical and

physiological characteristics of ND and T1DM respectively were; age: mean 27, $s = 7$; 35, $s = 12$ years; body mass: 79, $s = 6$; 84, $s = 12$ kg; glycosylated haemoglobin (HbA1c): 5.3, $s = 0.3$; 8.1, $s = 0.6\%$; $\dot{V}O_{2\max}$: 48.3, $s = 8.8$; 41.8, $s = 4.9$ ml $\text{kg}^{-1} \text{min}^{-1}$. After two preliminary visits participants completed two main 45 min exercise trials in a randomised order, an intermittent running protocol designed to simulate intermittent games play (INT; Nicholas, *et al.*, 2000: *Journal of Sports Science* 18:97–104.) and a continuous treadmill run (CON) that matched mean rates of INT oxygen consumption. Blood samples were taken at rest and for 3 h post-exercise to determine lactate, serum triglyceride (TG), non-esterified fatty acid (NEFA), high (HDL) and low (LDL) density lipoproteins. Data were analysed using two-way ANOVA with post-hoc testing where appropriate, $P < 0.05$.

Rates of oxygen consumption ($\dot{V}O_{2\max}$) were similar between conditions (ND: CON 72, $s = 5$ INT 73, $s = 5$; T1DM: CON 77, $s = 8$ INT 77, $s = 5\%$, $P > 0.05$). Peak blood lactate concentrations were greater in INT compared with CON (INT: ND 6.8, $s = 3.0$, T1DM 9.5, $s = 2.8$ mM *versus* CON: ND 1.9 \pm 0.8, T1DM 3.7 \pm 2.1 mM, $P < 0.05$). TG peaked immediately post-exercise in both groups under CON and INT then returned to rest values from 30 min onwards. Peak NEFA occurred 5–15 min post-exercise, returning to rest values at 60 min then increasing from 2 h onwards ($P < 0.05$). Similarly, HDL- and LDL-chol followed the same time-course ($P < 0.05$). There were no differences in lipid variables between INT or CON conditions in T1DM or ND.

The results demonstrate significant alterations in lipid metabolism of T1DM patients following INT and CON exercise. However, there were no differences between the exercise types when performed at the same physiological intensity, despite a different anaerobic contribution. These data suggest the pattern of exercise does not influence the post-exercise lipid response when the physiological cost of exercise is similar.

HPHP3-13

Changes in maximal and submaximal physiological and metabolic variables before and after a one-week European mountain trek

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It is well established that endurance training lowers both resting and submaximal exercise heart rate, and improves aerobic fitness (Scheuer & Tipton, 1977: *Annual Review of Physiology*, 39, 221–251). Less well understood is the time course of adaptation. The purpose of the present study was to investigate changes in cardiorespiratory and metabolic responses to both maximal and submaximal treadmill exercise following a week-long alpine trek (Tour du Mont Blanc; TMB, 160 km).

Over a 9-year period (1999–2007) 79 men (Age mean 21.1, $s = 2.1$ years; Height 1.79, $s = 0.06$ m; Body mass 77.3, $s = 9.7$ kg) and 72 women (Age mean 21.6, $s = 4.9$ years; Height 1.66, $s = 0.06$ m; Body mass 62.3, $s = 8.7$ kg) (NS , $P < 0.01$ and $P < 0.01$) completed a maximal physiological assessment before and after the TMB. Sixty-two men and 50 women also completed submaximal physiological assessments before and after the trek. The study received University ethical committee approval and participants gave prior written informed consent.

Participants initially performed a submaximal motorized treadmill test (Woodway, PPS 55), speed 1.50 $\text{m} \cdot \text{s}^{-1}$, at 0, 4, 8, 12 and 16% gradients. After a 5-min rest, using a modified Balke protocol (Balke & Ware, 1959: *United States Armed Forces Medical Journal*, 10, 675–688), participants then exercised to voluntary exhaustion. These tests were repeated 10-days later, following the TMB. Exercise heart rate (Polar Beat, Kempele, Finland), oxygen uptake ($\dot{V}O_2$; indirect spirometry, Servomex 1400 series analysers) and blood lactate concentrations (Analox Instruments) were measured during steady-state and maximal exercise

Table I. Physiological and blood lactate responses before and after a one-week alpine trek.

Gradient (%)	Oxygen uptake ($\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$)		Heart rate ($\text{b} \cdot \text{min}^{-1}$)		Oxygen pulse ($\text{mL} \cdot \text{beat}^{-1}$)		Blood lactate ($\text{mmol} \cdot \text{L}^{-1}$)	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
0	15.2 \pm 1.5	15.3 \pm 1.5	107 \pm 19	102 \pm 13**	10.1 \pm 2.2	10.6 \pm 2.2**	1.35 \pm 0.48	1.28 \pm 0.56**
4	19.2 \pm 1.6	19.3 \pm 1.4	117 \pm 15	112 \pm 13**	11.8 \pm 2.5	12.1 \pm 2.4*	1.15 \pm 0.44	1.03 \pm 0.43**
8	24.3 \pm 1.7	24.5 \pm 1.5	130 \pm 20	126 \pm 15**	13.4 \pm 3.0	13.8 \pm 2.9**	1.40 \pm 0.50	1.24 \pm 0.50**
12	30.1 \pm 2.0	30.5 \pm 1.7*	149 \pm 18	144 \pm 17**	14.5 \pm 3.2	15.0 \pm 3.2**	2.18 \pm 0.92	1.81 \pm 0.79**
16	36.5 \pm 2.8	36.6 \pm 1.8	159 \pm 13	154 \pm 12**	16.9 \pm 3.4	17.3 \pm 3.1*	3.14 \pm 1.27	2.51 \pm 1.02**

Notes: * $P < 0.05$ and ** $P < 0.01$, significant difference between pre- and post-TMB values.

using standard laboratory techniques. Pre- versus post-trek differences were assessed using Student's *t* test for paired samples. Differences between men and women were determined using ANOVA and post-hoc Student's *t* tests (SPSS version 14).

There were significant increases in maximal aerobic power following the TMB for both men (57.4, *s* = 5.6 versus 58.7, *s* = 5.3 mL · kg⁻¹ · min⁻¹) and women (43.7, *s* = 5.7 versus 46.2, *s* = 5.4 mL · kg⁻¹ · min⁻¹). The magnitude of the increase in maximal aerobic power was similar in both men and woman. Submaximal data for men and women are shown in Table I.

The data suggest that just 7-days of extensive mountain walking (~6–8 hours per day) resulted in a greater oxidation of metabolic substrates and less reliance on lactate metabolism, together with an attenuated heart rate response, at the same absolute treadmill speed and gradients.

HPHP3-15

The effects of an aerobic dance intervention programme on physiological factors in adolescent girls

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Background. Decreasing levels of physical activity (and thus general fitness) in young people is of increasing concern in our modern society because of the increasing trends of obesity and type II diabetes which are recognised precursors of adult chronic disease (Boreham and Riddoch 2001, *Journal Sports Sciences*, 19, 915–929). Participation in physical activity has been shown by Kimm *et al.* (2002: *New England Journal Medicine*, 347, 709–715) to decrease throughout adolescence with data in Scotland reporting that by age 13–15, only 41% of girls do at least 60 min of physical activity on each day of the week compared to 68% of boys (Scottish Government Statistics, 2003: *Physical activity, the Scottish health survey*. Scottish Executive: Edinburgh).

Aim. This study examined the effect of a 10-week aerobic dance intervention programme on body fat and aerobic fitness of adolescent girls.

Methodology. One hundred and six participants, mean age 12.9 years (*s* = 0.34), height 156.3 cm (*s* = 3.52) and weight 52.03 kg (*s* = 7.21) were recruited from three secondary schools to participate in this study. Ethical approval was granted by the

University's ethics committee for research involving human participants with written consent being signed by students and parents prior to the study. Female only physical education (PE) classes (with girls who typically had a very low adherence to PE) were randomly assigned to a dance intervention group (59 girls) or a control group (47 girls) who undertook their normal PE sessions. Physiological assessment including height, weight, skinfold thickness and aerobic fitness was carried out on all participants. In addition, POLAR heart rate monitors were used to record the intensity of each session.

Results. Heart rate monitoring of sessions indicated that all of the dance classes were taught at an intensity above 60% maximum heart rate which has been shown necessary to illicit health benefits (ACSM, 2000). None of the control sessions reached this level of intensity. Significant improvements were made in aerobic fitness in the dance group with mean Leger test results increasing from 4.986 to 5.724 (*P* < 0.001) with a significant reduction in skinfold thickness in the dance group with a decrease from a mean of 71.48–51.09 mm.

Conclusion. Aerobic dance is a useful tool in trying to improve activity levels and thus improve fitness and reduce body fat in adolescent girls. A longitudinal intervention study with a larger cohort would help to investigate the potential benefit further.

HPHP3-16

An incremental step test for use in laboratory and field based hypoxia

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Peak oxygen consumption ($\dot{V}O_{2peak}$) declines with altitude and a given workload is more strenuous than when performed at sea level. Therefore investigations examining change in dependent variables in hypoxia cannot solely be attributed to hypoxia *per se*. Hence it is often appropriate to incorporate comparisons between exercise at the same relative (% $\dot{V}O_{2peak}$) and absolute workload at sea level compared to altitude. In accord this study aimed to evaluate an incremental step test designed to identify workloads required to elicit blood lactate threshold (T_{lac}) and $\dot{V}O_{2peak}$ at sea level and altitude.

With local ethical committee approval nine males (age mean 21.4, *s* = 1.9 years; body mass mean 80.4, *s* = 13.9 kg) undertook two discontinuous incremental step (height 25 cm; interval 30 sec) tests to

Table I. Key physiological variables at T_{lac} and VEX (mean \pm s).

	N	H
$\dot{V}O_2$ peak ($L \cdot min^{-1}$) [†]	3.47 \pm 0.57	2.77 \pm 0.41
HR peak (beats $\cdot min^{-1}$)	188 \pm 8	185 \pm 8
$\dot{V}_{E\ STPD}$ peak ($L \cdot min^{-1}$)	123.2 \pm 17.5	115.5 \pm 15.2
RER [‡]	1.09 \pm 0.05	1.17 \pm 0.07
SpO ₂ (%) [†]	93 \pm 4	76 \pm 6
$\dot{V}O_2$ ($L \cdot min^{-1}$) at T_{lac} [*]	2.31 \pm 0.34	2.04 \pm 0.34

Notes: * $P < 0.05$, [‡] $P < 0.01$, [†] $P < 0.001$; effect size $\eta^2 = 0.37$ to 0.87.

volitional exhaustion (VEX) whilst breathing either normoxia (N) or hypoxia (H; $F_{I}O_2 = 0.14$, equivalent to breathing ambient at ≈ 3000 m). Stepping commenced at 15 steps $\cdot min^{-1}$ and was increased by 5 steps $\cdot min^{-1}$ every 3 min thereafter. T_{lac} was determined according to Cheng *et al.* (1992: *International Journal of Sports Medicine*, 13, 518–522). N and H were compared using paired *t* tests.

Stepping at 15 steps $\cdot min^{-1}$ elicited a similar $\dot{V}O_2$ in N and H that represented 31% and 39% $\dot{V}O_{2peak}$ in N and H respectively. Although $\dot{V}O_2$ at T_{lac} was lower in H (59% *versus* N, 68% specific $\dot{V}O_{2peak}$; Table I) step rate did not vary (N, 31 \pm 3 compared to H, 30 \pm 2). This reflected an average of 4 work stages being completed prior to reaching T_{lac} . $\dot{V}O_{2peak}$ was achieved at 42 \pm 4 steps $\cdot min^{-1}$ in N and 37 \pm 4 steps $\cdot min^{-1}$ in H.

The current protocol allowed adequate work stages prior to T_{lac} to enable relative submaximal workloads to be defined; and absolute workloads to be compared between sea level and moderate altitudes.

HPHP3-17

The effect of carbohydrate ingestion on cardiorespiratory responses to inclined walking during normobaric hypoxia

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At altitude carbohydrate (CHO) is preferentially metabolised and muscle CHO stores are reduced. Since carbon dioxide, a respiratory stimulant, is produced in larger amounts when CHO is metabolised compared to other macronutrients; it is plausible that increased CHO availability, via supplementation, at altitude could improve arterial haemoglobin oxygen saturation (SpO₂%) during exercise. Hence this study compared responses to CHO *versus* placebo (PLAC) ingestion during uphill walking in hypoxia.

With local ethical committee approval seven males (age mean 24.2, $s = 4.4$ years; body mass mean 70.1,

$s = 6.8$ kg; normoxic (N) and hypoxic (H; $F_{I}O_2 = 0.14$, equivalent to breathing ambient at ≈ 3000 m, $\dot{V}O_{2peak}$ mean 3.88 $s = 0.33$, mean 3.10 $s = 0.34$ $L \cdot min^{-1}$ respectively) conducted two 60 min bouts of inclined (15%) walking (60% H $\dot{V}O_{2peak}$) whilst breathing H 2 hours post glycogen depletion (60 min, 15% incline, 70% N $\dot{V}O_{2peak}$ whilst breathing N). In a randomised cross-over design either 250 ml of CHO (6.4 g $\cdot 100$ mL⁻¹) or matched PLAC was ingested at -5, 15, 30 and 45 min of each trial. General linear model analysis of variance was applied. Stated values were taken at 45 min and *P* values are main effects for condition.

CHO ingestion increased blood glucose compared to PLAC by mean 0.8, $s = 1.1$ mmol $\cdot L^{-1}$, ($P < 0.001$, effect size $\eta^2 = 0.47$). Unexpectedly SpO₂ tended to be lower throughout exercise in CHO (mean 74.0, $s = 1.7$ *versus* mean 75.6, $s = 2.3$ %, $P = 0.112$, effect size $\eta^2 = 0.36$) although $\dot{V}O_2$, $\dot{V}_{E\ BTPS}$ and RER did not vary between trials. Heart rate however was highest in CHO (mean 154, $s = 7$ *versus* PLAC mean 150, $s = 10$ $bt \cdot min^{-1}$, $P = 0.061$, effect size $\eta^2 = 0.18$).

Recently an increased resting HR with CHO ingestion in hypoxia, potentially explained by increased sympathetic activity resulting from CHO ingestion, has been reported (Golja *et al.*, 2008: *High Altitude Medicine and Biology*, 9, 53–62). Therefore since oxygen delivery (DO₂) is controlled to be appropriate to the rate of oxygen consumption (Wolff, 2003: *Advances in Experimental Medicine and Biology*, 510, 279–284) it is likely that the observed reciprocal relationship between heart rate and SpO₂ is indicative of maintaining a constant DO₂ to tissues at this exercise intensity.

Further studies should examine the effects of adjusting exercise intensity, CHO beverage content and magnitude of hypoxia.

HPHP3-18

Heart rate variability: Effect of exercise intensity on post-exercise response

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A recent exercise bout has been shown to result in acute transient alterations in autonomic nervous system function as evident from heart rate variability (HRV) outcomes (Poher *et al.*, 2004: *Medicine & Science in Sports & Exercise*, 36 (7), 1140–1148). In order to further explore the HRV response following a single bout of exercise, the response following

moderate and severe intensity exercise was compared.

Following institutional ethics committee approval of procedures, 16 healthy and experienced runners initially performed a progressive exercise test to exhaustion to determine ventilatory threshold (T_{vent}) and maximal oxygen uptake ($\dot{V}O_{2\text{max}}$) and the speed at which T_{vent} and $\dot{V}O_{2\text{max}}$ were attained ($v\text{-}T_{\text{vent}}$ and $v\text{-}\dot{V}O_{2\text{max}}$). Participants completed two distance-matched conditions; a moderate (90% $v\text{-}T_{\text{vent}}$) and a severe (1 $\text{km}\cdot\text{h}^{-1}$ below $v\text{-}\dot{V}O_{2\text{max}}$) intensity interval training session that comprised 6×800 m runs separated by 3 min recovery periods. Prior to (-1 h) and at intervals following ($+1$ h, $+24$ h, $+48$ h, $+72$ h) each condition, participants sat quietly for 20 min whilst breathing at 0.20 Hz (12 breaths $\cdot\text{min}^{-1}$). Cardiac cycle R-R interval data were collected over the final 5 min of each 20 min period. Time domain (RRAV, RRSD, rMSSD and pNN50) and frequency domain (TP, LF, HF and LF:HF) outcomes were determined. Two factor RMANOVA revealed a condition \times time interaction ($P < 0.05$) for RRSD, rMSSD, pNN50 and TP, with outcomes lower at $+1$ h following the severe intensity condition ($P < 0.01$). Following ($+1$ h) the severe intensity condition, a main effect for time was observed for RRAV, RRSD, rMSSD, pNN50 and HF, where outcomes showed a decrease ($P < 0.05$), and LF showed an increase ($P < 0.05$) when expressed in normalised units. Compared with -1 h, no changes were observed at $+24$, $+48$, $+72$ h for any outcome. Findings indicate that a severe intensity exercise bout is associated with a post exercise shift in heart rate variability outcomes towards an increased sympathovagal balance.

Although unlikely, the influence of exercise duration cannot be excluded from the present findings. The apparent influence of exercise intensity on autonomic balance has health and sport performance implications.

HPHP3-19

The effect of the rotor crank system on time-trial cycling performance

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The Rotor (ROT) is a cycle crank configuration that allows the pedals to move independently in an attempt to eliminate the “dead spots”, where torque output is minimal. Delta efficiency has been found to

be significantly improved during an incremental test when using ROT in a group of untrained cyclists (Santalla *et al.*, 2002: *Medicine and Science in Sports and Exercise*, 34, 1854–1858). However, no study has investigated whether ROT affects cycling performance directly. Therefore, the purpose of this study was to investigate the effect of ROT on time-trial cycling performance.

Following institutional ethics approval, 12 competitive male cyclists (age mean 34.6, $s = 7.1$ years, mass mean 75.9, $s = 7.8$ kg, $\dot{V}O_{2\text{max}}$ mean 4.5, $s = 0.3$ $\text{L}\cdot\text{min}^{-1}$, W_{max} mean 363, $s = 37.7$ W) provided written informed consent to participate. All participants completed two 40.23 km time-trials on a King-cycle ergometer in each of two conditions, i) using conventional bicycle cranks (CON) and ii) using the Rotor system (ROT). Cyclists trained for 6-weeks prior to the experimental trials as either habitual ROT users or habitual CON users. Power output, speed, heart rate, $\dot{V}O_2$, RER and gross efficiency were measured for the duration of each time-trial.

A two-way repeated measures ANOVA (pedalling system used during the test [CON, ROT] \times habitual pedalling system [CON, ROT]) was performed to determine if there was a significant condition effect on the following variables: power output, speed, heart rate, $\dot{V}O_2$, RER and gross efficiency. Statistical significance was set at $P < 0.05$ for all tests. Power output was not different between conditions (CON mean 255, $s = 44$ W *versus* ROT mean 253, $s = 40$ W; $P > 0.05$). Indeed, no effect due to the pedalling system used during tests was found for any of the measured variables ($P > 0.05$). Furthermore, there was no interaction effect between the two factors for any of the measured variables ($P > 0.05$). However, there were marked differences between conditions for some individuals. For example, power output was $\sim 11\%$ higher during the CON trial *versus* the ROT trial for one subject but $\sim 12\%$ lower in another.

These results suggest that the Rotor crank system does not impact on time-trial cycling performance. However, marked differences were observed between CON and ROT in some individuals, suggesting that ROT may be beneficial in some instances.

HPHP3-20

Physiological responses to prolonged load carriage during level and downhill treadmill walking

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Load carriage using backpacks is undertaken both recreationally (Ainslie *et al.*, 2005: *Sports Medicine*, 3, 619–647) and as an occupational task (Knapik *et al.*, 1996: *Applied Ergonomics*, 27, 207–216). The purpose of this study was to examine the differences in physiological responses to 2 hours of load carriage (25 kg backpack) during treadmill walking on level (0%) and downhill gradients (–8%).

With ethical approval, 10 male participants (age mean 30, $s = 8$ years, body mass mean 79.4, $s = 8.3$ kg, height mean 1.79, $s = 0.05$, $\dot{V}O_{2\max}$ mean 55.1, $s = 5.6$ mL·kg^{–1}·min^{–1}) volunteered to complete 2 experimental conditions, walking on a treadmill at 6.5 km·h^{–1} for 2 h: (1) level walking 25 kg backpack [LWLC] and (2) downhill walking (–8%) 25 kg backpack [DWLC]. Oxygen uptake ($\dot{V}O_2$), respiratory exchange ratio (RER), heart rate, plasma glucose and lactate and stride frequency were measured at 5 minutes and 15 min intervals thereafter. Differences were assessed using pre-planned paired *t* tests, statistical significance was set at $P < 0.05$.

Mean $\dot{V}O_2$ during DWLC was lower than LWLC (mean 19.2, $s = 2.1$ versus mean 25.1, $s = 2.8$ mL·kg^{–1}·min^{–1}, $P < 0.001$), but there was no difference in the increase in $\dot{V}O_2$ over time (mean 4.3, $s = 2.5$ versus mean 3.9, $s = 2.3$ mL·kg^{–1}·min^{–1}, $P = 0.411$). However, the percentage increase in $\dot{V}O_2$ from the baseline during the 120 min was greater for DWLC compared to LWLC (mean 25, $s = 15$ versus mean 17, $s = 10$ %, $P = 0.027$). Cardiovascular drift occurred between 5 and 120 min for LWLC (mean 116, $s = 3$ to mean 141, $s = 23$ beats·min^{–1}, $P = 0.001$) and DWLC (mean 103, $s = 9$ to mean 126, $s = 21$ beats·min^{–1}, $P = 0.001$); there was no difference between conditions ($P = 0.659$). Between 5 and 120 min, RER decreased during LWLC only (mean 0.90, $s = 0.09$ to mean 0.83 $s = 0.04$, $P = 0.021$) and stride frequency increased during DWLC only (mean 64, $s = 3$ to mean 66, $s = 4$ steps·min^{–1}, $P = 0.043$). There were no differences between DWLC and LWLC in mean plasma lactate concentration (mean

0.75 $s = 0.18$ versus mean 0.92 $s = 0.26$ mmol·L^{–1}, $P = 0.890$) or mean plasma glucose concentration (mean 4.37 $s = 0.33$ versus mean 4.19 $s = 0.41$ mmol·L^{–1}, $p = 0.189$).

Load carriage on level and downhill gradients induces different physiological responses. The increase in $\dot{V}O_2$ and heart rate over time did not appear to be simply a factor of exercise intensity. Differences in physiological responses during load carriage on level and downhill (–8%) gradients may relate to differences in substrate oxidation, muscle fatigue/damage and mechanical efficiency.

HPHP3-21

The inter-day reliability and concurrent validity of maximal sprint running performed on a non-motorised treadmill

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The reproducibility of sprint running performance variables obtained on a non-motorised treadmill (NMT) has received limited research attention. Furthermore, the correlation between sprint performance on a NMT and over-ground sprint running remains to be clearly elucidated. Accordingly, the purpose of the current investigation was to examine both the inter-day reliability of 10, 20 and 30 m NMT sprint running performances and their concurrent validity against equivalent over-ground running distances. Fourteen healthy adults (male, $n = 12$, female, $n = 2$; age mean 23.7, $s = 5.7$ years, body mass mean 77.4, $s = 10.7$ kg, stature mean 177.3, $s = 7.7$ cm) participated in the study. Following habituation, participants undertook two assessments of sprint performance on a Woodway NMT and one assessment of sprint performance on an outdoor all weather surface. Randomly ordered trials were separated by 48 to 72 h, each consisting of three sprints interspersed with 3 minutes recovery. Median

Table I. Reliability and concurrent validity of NMT sprint running variables.

	TEM (absolute / relative)	Limits of agreement	ICC	<i>r</i>
10 m sprint time (s)	0.16/6.04%	0.03 ± 0.45	0.86	0.64*
20 m sprint time (s)	0.16/3.5%	0.34 ± 0.45	0.94	0.77*
30 m sprint time (s)	0.19/2.8%	0.07 ± 0.52	0.96	0.82*
Mean velocity (m·s ^{–1})	0.13/2.87%	–0.34 ± 0.38	0.94	0.78*
Peak velocity (m·s ^{–1})	0.13/2.47%	–0.01 ± 0.38	0.95	
Time to peak velocity (s)	0.45/11.41%	0.06 ± 1.3	0.78	
Mean power (W)	144.5/6.2%	21.1 ± 413.5	0.83	
Peak power (W)	384.4/10.47%	161.6 ± 1055.6	0.65	

Note: * $P < 0.05$.

values for 10, 20 and 30 m sprint times and mean velocities were recorded for both modes of assessment, with the addition of NMT peak velocity, time to peak velocity, mean and peak power measurements. Table I presents the reliability and validity (r) statistics for the NMT sprint performance.

The findings indicate that 20 and 30 m sprint times and mean and peak velocities on a NMT provide a reliable measure of sprinting performance. Furthermore, moderate to strong correlations between 20 and 30 m NMT and over-ground sprint times and velocities suggest that the NMT can provide a viable indication of sprint performance in the field.

HPHP3-22

The physiological response and reproducibility of a laboratory-based exercise protocol that simulates the frequently changing activity pattern of soccer: A preliminary study

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Various researchers have attempted to replicate the physiological demands of soccer in a controlled setting using laboratory-based simulations. However, previous soccer simulations included a change in the activity pattern approximately every 20–60 s. Soccer players typically perform between 800–1000 discrete bouts of activity during a game, with a change in activity occurring once every 4–7 s. To achieve a more realistic simulation of soccer match-play a higher frequency of activity change is required. Therefore, the aim of this study was to examine the physiological response and reproducibility of a laboratory-based intermittent treadmill protocol that was devised to reflect the frequently changing activity pattern of soccer.

Ten male semi-professional soccer players (mean age 23, $s = 3$ year, height 1.80, $s = 0.03$ m, body mass 74.2, $s = 3.4$ kg) completed the protocol on two occasions, separated by 7 days. In addition, each player performed a competitive soccer match where heart rate was recorded continuously during match-play and fingertip blood samples were taken immediately after each half. The protocol was performed on a programmable motorised treadmill (Woodway, ELG55, Weil am Rhein, Germany) and attempted to mimic the intermittent nature of soccer match-play. The percentage of total time spent in each activity within the protocol was based on a recent large scale time-motion analysis of elite soccer players (Bradley *et al.*, in press: *Journal of Sports Sciences*), using the following categories and

speeds: standing ($0 \text{ km} \cdot \text{h}^{-1}$), walking ($7 \text{ km} \cdot \text{h}^{-1}$), jogging ($12 \text{ km} \cdot \text{h}^{-1}$), running ($17 \text{ km} \cdot \text{h}^{-1}$), high-speed running ($22 \text{ km} \cdot \text{h}^{-1}$) and sprinting ($27 \text{ km} \cdot \text{h}^{-1}$). The protocol was structured around two identical periods of 3×15 min repetitive cycles separated by a 15 min half-time interval. Each 15 min cycle consisted of 117 discrete bouts of activity whereby an activity change occurred every 7 s: standing $\times 6$, walking $\times 54$, jogging $\times 30$, running $\times 15$, high-speed running $\times 9$ and sprinting $\times 3$.

No differences were observed between trials for mean heart rate (164, $s = 10$ versus 162, $s = 12$ beats $\cdot \text{min}^{-1}$), ratings of perceived exertion (14, $s = 1$ versus 14, $s = 1$), oxygen uptake (3.1, $s = 0.7$ versus 3.0, $s = 0.9 \text{ L} \cdot \text{min}^{-1}$; core body temperature (38.7, $s = 0.3$ versus 38.5, $s = 0.4^\circ\text{C}$) body mass loss (2.0, $s = 0.4$ versus 2.1, $s = 0.5$ kg) or blood lactate (4.3, $s = 1.5$ versus 4.0, $s = 2.7 \text{ mmol} \cdot \text{L}^{-1}$) and glucose concentrations (4.6, $s = 1.5$ versus 4.8, $s = 2.7 \text{ mmol} \cdot \text{L}^{-1}$). Mean heart rate and blood lactate concentrations during the protocol were similar to values obtained during match play (167, $s = 14$ beats $\cdot \text{min}^{-1}$ and 4.8, $s = 2.9 \text{ mmol} \cdot \text{L}^{-1}$).

The results demonstrate that the physiological responses during the protocol were reproducible and that the frequently changing activity pattern of the current protocol provides a more representative model of the match demands of soccer than previous laboratory-based soccer-specific simulations.

HPHP3-23

The Yo-Yo intermittent endurance test: positional and season-to-season differences in elite youth soccer players

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Yo-Yo intermittent test performance has been well reported in senior soccer players with regard to competition level, playing position and seasonal variation. However, despite the increasing focus on the physiological monitoring of elite youth soccer players, surprisingly no studies to date have been published regarding Yo-Yo intermittent endurance test level 2 (Yo-Yo IE2) performance. Therefore, the aims of this study were to evaluate the sensitivity of the Yo-Yo IE2 test to detect season-to-season variations and discriminate between test performances for different playing positions in elite youth soccer players.

With institutional approval, 37 youth soccer players signed to an English FA Premier League club (mean age 17, $s = 1$ year, height 1.78, $s = 0.06$ m, body mass 70.7, $s = 5.9$ kg) carried out the Yo-Yo IE2 test on four occasions during the season over three consecutive seasons. The Yo-Yo IE2 test consists of repeated 20 m shuttle runs at progressively increasing speeds with a 5 s period of active recovery between shuttles. Failure to achieve the shuttle run on two successive occasions resulted in termination of the test and the distance covered was recorded and represented the test result. All testing sessions were performed indoors on an artificial surface on a 2×20 m running lane marked by cones. A one-way ANOVA was used to evaluate differences between playing positions and season-to-season changes in Yo-Yo IE2 test performance. Statistical significance was set at $P < 0.05$.

The mean distance covered in the Yo-Yo IE2 test was 2381, $s = 565$ m. For a group of 15 players, Yo-Yo IE2 test performance was 10% and 15% higher ($P < 0.01$) in the first (2411, $s = 593$ m) and middle phase of the season (2560, $s = 574$ m) compared to preseason (2171, $s = 519$ m). The Yo-Yo IE2 test performance at the end of the season (2381, $s = 575$ m) was not different to the first phase of the season (2411, $s = 593$ m). During the season, 12 players improved their Yo-Yo IE2 test performance, whereas only three players had decreases in performance ranging from 40–240 m. The coefficient of variation between Yo-Yo IE2 test performances at the start and the end of the season and between seasons 1 and 3 were 5.5% and 9.9%, respectively. It was observed that central (2638, $s = 331$ m) and wide midfielders (2520, $s = 546$ m) had a higher Yo-Yo IE2 test performance than attackers (2176, $s = 444$ m), full-backs (2200, $s = 313$ m) and centre backs (2143, $s = 203$ m) but this just failed to reach statistical significance.

The results demonstrate that the Yo-Yo IE2 test can be used to quantify the capacity of elite youth soccer players to perform intense intermittent exercise. Furthermore, the Yo-Yo IE2 test was shown to be a sensitive tool in detecting positional variations and seasonal changes in performance levels of youth soccer players and could be used in conjunction with other measures to track physiological maturation over consecutive seasons.

HPHP3-24

Acceleration and top-speed characteristics of international soccer players

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The ability to accelerate and reach top-speeds quickly is an essential component of game-deciding situations in intermittent team sports such as soccer. However, limited research has been undertaken concerning the high-speed capabilities of international soccer players. Therefore, the aim of this study was to examine the acceleration and top-speed capabilities of a sample of international standard soccer players to provide an insight into any fatigue-related changes in high-speed performance.

With institutional ethics approval, 10 international standard soccer players were analysed using a multiple-camera computerised tracking system (ProZone Group Ltd[®], Leeds, UK). Players' movements were observed during the game by eight cameras positioned in the stadium at roof level. Activities were coded into the following categories: jogging ($7.2\text{--}14.3 \text{ km} \cdot \text{h}^{-1}$), running ($14.4\text{--}19.7 \text{ km} \cdot \text{h}^{-1}$), high speed running ($19.8\text{--}25.1 \text{ km} \cdot \text{h}^{-1}$) and sprinting ($> 25.2 \text{ km} \cdot \text{h}^{-1}$). Players' accelerations were divided into three subsets: low ($1.0\text{--}2.5 \text{ m} \cdot \text{s}^{-2}$), medium ($2.5\text{--}4.0 \text{ m} \cdot \text{s}^{-2}$) and high ($> 4.0 \text{ m} \cdot \text{s}^{-2}$). Top running speed was defined as the maximum running speed a player attained over 5 min periods of the game. Differences between the first and second half were determined using paired sample t tests. Differences between 5-, 15- and 45-min periods within a match were determined using one-way ANOVA with repeated measures. Statistical significance was set at $P < 0.05$.

Average sprint distances were not different in the first compared to the second half (8.5, $s = 4.5$ versus 6.4, $s = 1.0$ m) or the first and last 15 min period (7.3, $s = 2.8$ versus 6.9, $s = 2.5$ m). Players' top running speeds did not differ between the first and second half (7.8, $s = 0.4$ versus 7.7, $s = 0.3 \text{ m} \cdot \text{s}^{-1}$) or between the first and last 15 min period (7.6, $s = 0.5$ versus 7.8, $s = 0.6 \text{ m} \cdot \text{s}^{-1}$). No differences were found ($P < 0.05$) between halves for discrete bouts of low accelerations (311, $s = 16$ versus 330, $s = 21$), medium (53, $s = 6$ versus 53, $s = 6$) or high accelerations (6, $s = 2$ versus 7, $s = 2$). Similarly, no differences were observed between the first and last 15 min for discrete bouts of low accelerations (112, $s = 16$ versus 122, $s = 27$), medium (18, $s = 6$ versus 18, $s = 7$) or high accelerations (2, $s = 2$ versus 3, $s = 2$). However, accelerations were highest ($P < 0.01$) when players moved from jogging-sprinting (3.8, $s = 0.3 \text{ m} \cdot \text{s}^{-2}$) compared to jogging-high speed running (3.1, $s = 0.5 \text{ m} \cdot \text{s}^{-2}$) or jogging-running (2.2, $s = 0.2 \text{ m} \cdot \text{s}^{-2}$).

The results demonstrate that a sample of international soccer players show no fatigue related changes in high-speed capabilities during certain periods of a game. The current findings provide information about the acceleration and top-speed characteristics of elite soccer players, which could be useful in the

development of specific performance tests and speed and agility training drills.

HPHP3-25

Physiological response to simulated epee fencing in elite Polish female fencers

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There are few studies reporting physiological data on elite fencers (Nystrom *et al.*, 1990: *International Journal of Sports Medicine*, 11(2):136–139) with no apparent research relating specifically to elite female epee fencers. Such data would provide information for coaches and competitors regarding the physiological demands of fencing. Therefore the aim of the present study was to determine peak physiological responses of the Polish women's epee team as well as the physiological demands of a simulated competition.

Four members of the Polish female epee team (mean age = 24.8, $s = 3.3$ years, mean height = 178.5, $s = 8.7$ cm and mean body mass = 68.0, $s = 6.9$ kg) volunteered to take part. Participants completed an incremental exercise test to exhaustion on a treadmill to determine peak oxygen consumption ($\dot{V}O_{2\text{peak}}$) and peak heart rate (HR_{peak}). On a different day a series of simulated fights were undertaken with each fencer completing three fights. The simulated fight consisted of 3×3 min of fencing with 1 minute rest between each bout. This constituted one fight which replicated the maximum duration of an epee fight in an international competition. During each simulated fight mean oxygen consumption (Cosmed, Italy) and heart rate (Sport Tester Polar 720i, OY Kempele, Finland) were determined for each three minute bout and one minute rest period. Blood lactate (Dr Lange photometer, Germany) was determined at rest and during each rest period.

$\dot{V}O_{2\text{peak}}$ and HR_{peak} obtained during the incremental exercise test were mean 47.0, $s = 4.7$ ml \cdot kg⁻¹ \cdot min⁻¹ and mean 196, $s = 8$ beat \cdot min⁻¹. During the simulated fights fencers worked at an average exercise intensity of mean 74.4, $s = 4.2\%$ $\dot{V}O_{2\text{peak}}$ and mean 87.8, $s = 3.0\%$ HR_{peak} . Blood lactate concentrations at rest and at the end of each bout were 2.0 ± 0.2 , 2.9 ± 1.2 , 2.6 ± 0.9 and 2.9 ± 1.7 mmol \cdot L⁻¹ respectively. There were no differences in $\dot{V}O_2$, HR or blood lactate between the three minute bouts during a fight ($P > 0.05$).

The results demonstrate that although fencing is a high intensity intermittent sport the low blood lactate levels during each fight suggest it is mainly aerobic in nature. These data are important for the development of simulated fencing protocols in examining future fencing interventions.

HPHP3-26

Physiological demands of rock drumming – case study

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The physiological demands of different types of sport (Smith, 2006: *Journal of Sports Science and Medicine*, 5, 74–89) and physical activity (Abdelhamid & Everett, 1999: *Journal of Construction Engineering and Management*, 125, 47–52) have been documented. However, despite its worldwide popularity, rock drumming has received limited scientific enquiry. This is somewhat surprising given the intensity, duration and number of concerts played by professional rock drummers during National or International Tours (Smith, 2002: In *Blondie, from punk to the present*, edited by A. Metz. Musical Legacy Publications). The purpose of this study was to investigate the physiological demands of rock drumming through a longitudinal study of a professional rock drummer.

With institutional ethical approval a longitudinal case study (1997–2007) was undertaken on Clem Burke, drummer from the rock group Blondie. Physical characteristics during the data acquisition period were: (age range: 42–52 years, mass range: 79.5–84.3 kg). Drumming performance was undertaken using a Premier drum kit (Premier, Leicester, England) recorded at two outdoor and 10 indoor venues in England. The duration of each concert varied between 60–93 min. Throughout each performance heart rate was measured at 5-s intervals using short-range telemetry (Polar S810i, Kempele, Finland) and a 3-minute post performance finger-prick sample to determine blood lactate (Lactate pro analyser, Arkray, Japan). Results from the 2007 Manchester Apollo concert are presented to illustrate the typical response of playing “live”. Duration of concert was 82 min 7 s, comprising 19 songs (longest: “Rapture”: 10 minutes 7 seconds, shortest: “Please Please Me”: 1 minute 50 seconds). Highest peak heart rate for a song was recorded during “Union City Blue” (range 144–179 b \cdot min⁻¹, mean 155 b \cdot min⁻¹). Lowest peak heart rate was recorded during “Screamin Skin” (range 129–144 b \cdot min⁻¹,

mean $135 \text{ b} \cdot \text{min}^{-1}$). The mean heart rate for the concert was $145 \pm 13 \text{ b} \cdot \text{min}^{-1}$. A peak blood lactate value of $3.6 \text{ mmol} \cdot \text{L}^{-1}$ was recorded 3 min post performance.

It is evident that rock drumming may be classified as an intermittent activity relying heavily upon the interplay between aerobic and anaerobic energy systems, supporting the work of Smith *et al.* (2008: European College of Sports Sciences, Estoril, Portugal). Future research should focus on the physiological demands of energy supply to the leg *versus* arm muscles for different song tempos.

HPHP3-27

Aerobic fitness, autonomic control and resting blood glucose concentration in young men and women

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Earlier work highlighted the cardioprotective effect of aerobic fitness on mortality for men with elevated blood glucose concentrations (Kohl *et al.*, 1992: *Diabetes Care*, 15(2), 184–192). Recent work has identified associations between exercise, diabetes and autonomic control (Carnethon & Craft, 2008: *Exercise and Sport Sciences Reviews*, 36(1), 12–18). Therefore the purpose of the present study was to investigate relationships between heart rate variability (HRV), as an index of cardiac autonomic control, aerobic fitness and blood glucose concentrations.

The study received University ethical committee approval and all tests were explained both verbally and in writing before testing. Seventeen individuals volunteered to participate (men, $n=10$; women, $n=7$). Participants were divided into either moderate (1–2 sessions per week of $< 30 \text{ min}$ per session; MV) or high volume physical activity groups (> 3 sessions per week of $30\text{--}90 \text{ min}$ per session; HV). Aerobic fitness ($\dot{V}O_{2\text{max}}$, $\text{L} \cdot \text{min}^{-1}$) was estimated during submaximal cycle ergometry, blood glucose concentrations ($\text{mmol} \cdot \text{L}^{-1}$) were measured after an overnight fast, and after a glucose tolerance test (Ascensia). Supine heart rate and R-R intervals (time in milliseconds between successive R-waves) were measured during 20 min quiet lying and 5 min 70° head up tilt using short-range telemetry (Polar S810i). R-R data were analysed using time- and frequency-domain analysis together with non-linear (Poincaré) analysis (HRV Analysis Software, University of Kuopio, Finland). Differences between MV and HV were assessed by independent Student's *t* test (SPSS 14).

There was no difference in age (23.9 , s 3.3 *versus* 24.4 , s 2.8 years) or height (1.74 , s 0.1 *versus* 1.71 , s 0.1 m), MV *versus* HV respectively. However, MV were heavier compared with HV (78.0 , s 11.7 *versus* 61.2 , s 9.4 kg) ($P < 0.01$) and possessed lower values for aerobic fitness 2.72 , s 0.66 *versus* 3.64 , s $0.81 \text{ L} \cdot \text{min}^{-1}$ ($P < 0.05$). Supine HR was 64 ± 12 *versus* $61 \pm 7 \text{ b} \cdot \text{min}^{-1}$ for MV compared with HV (NS). There was no change in HRV for MV compared with HV using time-, frequency-domain or Poincaré analysis on going from supine to 70° head up tilt. Overall, there were strong correlations between Poincaré measures of HRV, estimated aerobic fitness and changes in blood glucose concentration.

Despite inappropriate levels of physical activity MV recorded similar resting blood glucose concentrations and heart rate measures to HV, presumably due to the innate plasticity of the autonomic nervous system in young people. Our preliminary results suggest further work, with a larger number of participants, is required to fully establish the nature of these relationships.

HPHP3-28

The accuracy and reliability of a fast ramp step test for aerobic fitness

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With widespread interest in monitoring fitness promotion schemes, quick reliable tests suitable for surveys or for use in primary care are needed. The aim of this study was to see if a fast ramp step test would allow good estimates of $\dot{V}O_{2\text{max}}$.

34 participants stepped on a 30 cm step at cadences (movement per minute) of 60 to 120/130 that increased linearly at either 10 or 30 movements per min^2 . The slow ramp took 6 min to increase from 60 to 120 movements/min (15 to 30 step cycles/min). The fast ramp took 2.33 min to increase from 60 to 130. Heart rate (Polar heart monitor) and oxygen consumption (MedGraphics Ultima CPX system) were measured. $\dot{V}O_{2\text{max}}$ was determined using a bicycle ramp protocol. Approved by UCL Research Ethics Committee.

Oxygen consumption was linearly related to cadence above a cadence of 85. The equations of the best-fitting lines were, for the $10/\text{min}^2$ ramp, $\dot{V}O_2 = 1.9 + 0.224 \cdot \text{Cadence}$ and for $30/\text{min}^2$, $\dot{V}O_2 = -0.5 + 0.217 \cdot \text{Cadence}$. These relations have similar slope to, but more negative intercept than, the relation described by Nagle *et al.* (1965: *Journal of Applied Physiology*, 20, 745–748).

Heart rate was also linearly related to cadence above cadence 85. The average best fitting equations were: $10/\text{min}^2$, $\text{HR} = 60 + 0.839 \cdot \text{Cadence}$; $30/\text{min}^2$, $\text{HR} = 71 + 0.617 \cdot \text{Cadence}$. Repeat measurements of HR-Cadence slopes had coefficient of variation 11–14%. The slope of the HR-Cadence relation was lower in fitter participants ($r = -0.41$ for $10/\text{min}^2$ and -0.45 for 30 ; $p < .05$). $\dot{\text{V}}\text{O}_{2\text{max}}$ was estimated from the heart rate data as follows. A notional maximum cadence was calculated by extrapolating the HR: Cadence best-fitting line to HR_{max} ($208 - 0.7 \cdot \text{age}$). $\dot{\text{V}}\text{O}_2$ for the cadence maximum was calculated using the equations above. $\dot{\text{V}}\text{O}_{2\text{max}}$ estimates correlated well with $\dot{\text{V}}\text{O}_{2\text{max}}$ measured with the maximal test ($r = 0.85$ for $10/\text{min}^2$; $r = 0.76$ for 30). The estimates from $10/\text{min}^2$ were lower than the bike $\dot{\text{V}}\text{O}_{2\text{max}}$ with an average difference of $-3.9 \text{ ml/min} \cdot \text{kg}$. However, the estimates from the fast ramp were close to $\dot{\text{V}}\text{O}_{2\text{max}}$ with average difference $0.4 \text{ ml/min} \cdot \text{kg}$. 95% Limits of agreement for $10/\text{min}^2$ are $+7$ and $-14 \text{ ml/min} \cdot \text{kg}$ and for 30 are $+15$ and $-14 \text{ ml/min} \cdot \text{kg}$.

It is concluded that repeatable data can be obtained about relative fitness of participants using fast ramp tests lasting only 2.3 min. However, absolute estimates of $\dot{\text{V}}\text{O}_{2\text{max}}$ lack precision.

HPHP3-29

Influence of body composition on physical function in chronic kidney disease patients

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Chronic kidney disease (CKD) patients on haemodialysis frequently display poor physical function, decreased aerobic capacity, and reduced quality of life. In contrast to the general population, increased body fat and body mass index have been associated with decreased morbidity and mortality within this population. This pilot study aimed to investigate the relationship between body composition and physical functioning in haemodialysis patients.

Following ethical approval and health screening, six CKD patients on haemodialysis (Age mean 50.8, $s = 9.0$ years, Mass mean 77.9, $s = 11.2$ kg, Height mean 1.68, $s = 0.12$ m) were recruited. Dual energy X-ray absorptiometry and bioelectrical impedance analyses were used to determine fat mass (%BM), total body water (%BM) and fat free dry mass (%BM). Participants also completed a symptom-limited incremental cycling test and isokinetic muscle function assessment on separate testing days.

The cycling protocol began at an intensity appropriate for each individual participant (15–50 W) and increased by 10 W every 2 min until exhaustion. Muscle function was assessed using an isokinetic dynamometer during concentric knee flexion and knee extension at both $60^\circ \cdot \text{s}^{-1}$ and $120^\circ \cdot \text{s}^{-1}$.

Spearman's rank correlation analyses revealed that fat mass (mean 32.7, $s = 14.7$ %BM) was negatively correlated with maximum work capacity (mean 87, $s = 24$ W; $r = -0.883$, $P = 0.020$) and peak oxygen consumption (mean 1.32, $s = 0.32 \text{ L} \cdot \text{min}^{-1}$; $r = -0.841$, $P = 0.036$) during incremental cycling. Additionally, fat free dry mass (mean 15.9, $s = 8.0$ %BM) was positively associated with peak oxygen consumption ($r = 0.841$, $P = 0.036$) and maximum work capacity ($r = 0.841$, $P = 0.036$). No significant correlations were identified between body composition and isokinetic muscle function at $60^\circ \cdot \text{s}^{-1}$ or $120^\circ \cdot \text{s}^{-1}$ ($r \leq 0.667$, $P \geq 0.148$).

Reduced fat free dry mass and increased adiposity were associated with inferior maximum work capacity and peak oxygen consumption, which have previously been previously associated with poor quality of life. Although these findings contrast previous research, demonstrating that elevated body fat is associated with improved morbidity and mortality in this population, it is possible that physical activity programmes, aimed at improving body composition, could benefit physical function and quality of life in CKD patients undergoing haemodialysis.

HPHP3-31

Heart rate responses to attacking and defending in coached and uncoached rugby league small-sided games

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Small-sided games (SSGs) provide an effective aerobic training method in rugby league (Gabbett, 2006: *Journal of Strength and Conditioning Research*, 20, 215–221). However, no research has examined the heart rate (HR) responses to attacking and defending roles within SSGs. Additionally, Rampinini *et al.* (2006: *Journal of Sports Science*, 25, 659–666) observed that coached SSGs produced higher HRs than uncoached SSGs in soccer. Therefore, the aim of this study was to analyse the HR responses of attacking and defending in coached and uncoached SSGs in two different junior age groups.

Following ethical approval, 17 junior players from a professional club (age mean 13.4, $s = 1.1$ years, stature mean 1.68, $s = 0.11$ m, body mass mean 61.5,

Table I. HR intensity (%HRmax and $b \cdot \min^{-1}$) for each SSG condition (mean \pm s).

	Defending			Attacking		
	Overall	12–13 Years	14–15 Years	Overall	12–13 Years	14–15 Years
Coached						
%HRmax	86.4 \pm 4.6	88.5 \pm 2.8	85.6 \pm 5.2	89.3 \pm 3.9	90.6 \pm 3.1	88.1 \pm 4.3
$b \cdot \min^{-1}$	176.4 \pm 12.1	180.6 \pm 10.1	169.6 \pm 11.7	180.1 \pm 10.2	184.4 \pm 7.2	176.3 \pm 11.4
Uncoached						
%HRmax	87.6 \pm 4.6	87.9 \pm 5.1	87.4 \pm 4.5	91.3 \pm 3.3	92.9 \pm 2.7	89.8 \pm 3.3
$b \cdot \min^{-1}$	180.0 \pm 9.5	182.6 \pm 8.5	177.7 \pm 9.3	183.8 \pm 9.3	187.1 \pm 8.2	180.4 \pm 9.6

$s = 14.9$ kg, HRmax mean 202, $s = 6.5$ $b \cdot \min^{-1}$) volunteered to participate in four four-minute conditioned SSGs (following habituation trials). Players engaged in SSGs both in attacking or defensive roles (non-contact) and in coached and uncoached conditions. HR responses to each game were recorded and expressed as overall and group (12–13 and 14–15 years) means and percent of maximum (%HRmax).

Average HRs exceeded 170 $b \cdot \min^{-1}$ ($>85\%$ HRmax) in all the SSGs (Table I). ANOVA revealed an effect of role ($P = 0.006$), with higher HRs when players were attacking (90.4% HRmax) than when defending (87.1% HRmax). HR responses were higher in the uncoached (89.5% HRmax) than the coached SSGs (87.9% HRmax) ($P = 0.007$). Neither the main effect of age nor the interaction effects were significant ($P > 0.05$).

This study demonstrates that these non-contact SSGs generate high HR responses, with a greater intensity obtained in attack. Coached SSGs elicited lower responses, which may reflect habituation to SSG training, resulting in players requiring little external motivation.

HPHP3-32

The effect of duration on pacing strategy in supramaximal cycling

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The exact test duration whereupon peak power is reduced by adoption of pacing strategy in supramaximal events is not known. The aim of this study was to investigate the effect of supramaximal cycling test duration on indices of power, anaerobic lactic energy contribution and perceived exertion. Furthermore we aimed to identify supramaximal test duration where the effect of intervention on power could be isolated from pacing strategy.

With institutional ethics approval nine physically active males undertook one of four supramaximal cycling tests at a load of $0.075 \times$ body mass (kg) in

random order separated by at least 24 h. Tests were of 5, 15, 30 or 45 s duration commencing from a seated stationary start on a mechanically braked cycle ergometer fit with power cranks. Extravascular lactate generation which reflects anaerobic lactic energy contribution was estimated using a biexponential 3 parameter model. Perceived exertion was indicated immediately at the end of each test using the Borg 6–20 scale.

Peak power was only lower in the 45 s compared to the 5 s and 15 s ($P < 0.008$) tests although there was no difference in the time to achieve this peak ($P > 0.008$). Mean power declined from 5 s to 45 s ($P < 0.001$). Mean power for each sequential 5 s interval was lower for the 1st and 2nd intervals for 45 s compared to 5 and 15 s tests ($P < 0.008$). Extravascular lactate generation increased with duration but was not significantly different between 30 and 45 s tests ($P > 0.008$). Perceived exertion increased with duration, although with no significant difference between the 15 and 30 s tests. Extravascular lactate generation during the test explained 59% of the variance in perceived exertion ($P < 0.01$).

Pacing strategy was apparent in supramaximal cycling of 45 s whilst not apparent in shorter duration tests up to 30 s. Test durations up to and including 30 s may be used in testing protocols where power needs to be isolated from strategy. During maximal short-term exercise pacing strategies seem to be adopted if the product of exercise intensity and duration approaches anaerobic capacity as indicated by extravascular lactate generation.

HPHP3-33

Differences in total estimated energy expenditure and substrate metabolism during 1500 m brisk walking and running in primary school children

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Although comparative estimated energy expenditure and substrate metabolism in brisk walking and running are known for adults, there are limited published reports for children. Such values would help to justify brisk walking as a means of preventing excess body fatness. The aim of this study was to compare the total estimated energy expenditure and substrate metabolism for 1500 m brisk walking and running, at freely-chosen speeds, in primary school children.

With institutional ethics approval 54 healthy participants aged 8–11 years old agreed to take part in this study. The protocol involved participants completing four laps around a marked 375 m track, in the school playground, either brisk walking or running. All children completed two trials, in a randomised order, which were performed with 30 min rest in between. Indirect calorimetry was measured using a Cosmed K4b² Portable Gas Analyser (COSMED s.r.l., Rome, ITALY). Differences between the within-subject repeated protocols were measured using a Wilcoxon Signed Rank Test using SPSS Version 13.0 (SPSS Inc, Chicago, IL). Statistical significance was accepted as $P < 0.05$.

During the 1500 m run than brisk walk there was a greater total oxygen uptake (effect size = 0.62), estimated energy expenditure (effect size = 0.89), and derived carbohydrate metabolism (effect size = 1.71) ($P < 0.001$). Conversely, there was more fat metabolism during the 1500 m brisk walk than the run (effect size = 1.29; $P < 0.001$).

The present study showed significantly higher total estimated energy expenditure and derived carbohydrate metabolism (17 and 49.3%, respectively) during running compared to brisk walking 1500 m in primary school children, at freely-chosen speeds. However, it was identified that there was a much greater total derived fat metabolism (74.6%) during the 1500 m brisk walk compared to the run. Therefore, although running increases energy expenditure more than brisk walking, in primary school children, participants probably utilised more fat during brisk walking of equivalent distance. This finding has important implications for intervention programmes

designed to reduce excess body fat accumulation in primary school aged children.

HPHP3-34

Validating body fat estimations in professional male super league rugby league players

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In Rugby League (RL), “backs” tend to be quick and agile, whereas “forwards,” who are involved with most of the physical contact, should be strong and powerful, and thus carry more lean body mass than “backs,” (Gabbett, 2005: *Journal of Sports Sciences*, 23(9), 961–976). Carrying excess body fat (BF) will adversely affect player mobility and speed. Accurate assessments of body composition are important, and are commonly carried out at the professional level using skinfold and air-plethysmography (BOD POD) analysis. The aim of this study was to validate the accuracy of both methods in a sample of *Super League* RL players, against dual-energy X-ray absorptiometry (DXA), which can be considered a “gold-standard” in body composition analysis (Rubiano, 2000: *Annals of the New York Academy of Sciences*, 904, 335–338).

With institutional ethics approval, 25 professional male *Super League* RL players (age mean = 25.5, $s = 3.4$ years; stature mean = 182.41, $s = 6.53$ cm; body mass mean = 96.57, $s = 10.78$ kg) underwent nine skinfold measures (biceps, triceps, subscapular, suprailiac, midaxillary, chest, abdomen, thigh, calf). Estimations of %BF were calculated by using body density equations according to Jackson & Pollock (J&P) for three and seven anatomical sites (1978: *British Journal of Nutrition*, 40(3), 497–504) and Durnin & Wormsley (D&W) (1974: *British Journal of Nutrition*, 32, 77–97), converted to %BF using the equation of Siri (1956: *Advances in Biological and Medical Physics*, 4, 239–280). Participants also

Table I. Mean ($n = 25$) total %BF calculated from different methods.

	iDXA	BOD POD	SF – J&P3	SF – J&P7	SF – D&W
Mean Total Body Fat (%)	15.78	12.83*	10.57*	17.92*	18.78*
r^2	–	0.827	0.824	0.692	0.807
Lower limit	–	–1.19	1.88	–8.16	–6.56
95% CI	–	2.78 to –0.39	0.61–3.16	–10.09 to –6.23	–7.92 to –5.19
Upper limit	–	7.09	8.55	1.94	0.57
95% CI	–	5.50–8.67	7.28–9.83	0.01 – 3.87	–0.79–1.93

Notes: (SF = Skinfold, J&P3 = 3 site Jackson & Pollock, J&P7 = 7 site Jackson & Pollock, D&W = 4 site Durnin & Wormsley).

*Significantly different compared with iDXA ($P < 0.001$).

underwent BOD POD analysis and a total-body DXA scan (iDXA, GE Lunar, Madison, WI). Results were analysed using paired *t* tests, linear regression and Bland & Altman plots.

Measures of %BF were significantly different between all methods and iDXA (Table I). Coefficients of Determination range from 69 to 83% and levels of agreement between iDXA and BOD POD, J&P3 and D&W methods are shown in Table I, however BOD POD and J&P3 site methods underestimated total BF mass by ~19 and ~33% respectively; J&P7 site and D&W equations overestimated by ~14 and ~19% respectively. BOD POD and skinfold methods using J&P, D&W and Siri equations are not valid for the accurate measurement of %BF in professional male *Super League* RL players. Where accurate estimates of BF are required these methods should not be used, DXA or other equivalent criterion measures should be used.

HPHP3-37

The effect of training in simulated altitude for 6 weeks upon lactate parameters

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Endurance athletes occasionally use normobaric hypoxia (NH), to intensify the training stimulus and increase $\dot{V}O_{2\max}$ (Dufour *et al.*, 2006: *Journal of Applied Physiology*, 100, 1238–1248). The effect of NH upon physiological “thresholds” such as lactate threshold is not well understood. The aim was to identify the difference between running velocity at specific lactate parameters in normobaric hypoxia

(NH; $F_{I}O_2 = 0.160 \sim 2100$ m altitude) *versus* control conditions (SHAM; $F_{I}O_2 = 0.209$) and following 6 weeks training.

Initially (week 1), eight elite male distance runners ($n = 8$; age mean 19.2, $s = 1.1$ years; stature mean 1.81, $s = 0.1$ m; $\dot{V}O_{2\max}$ mean 64.9, $s = 2.1$ ml · kg⁻¹ min⁻¹) completed a discontinuous incremental treadmill test (STEP) in SHAM and NH. Subsequently, 6 weeks of NH ($n = 4$) or SHAM ($n = 4$) training were completed (2 sessions · week⁻¹; 20 mins treadmill running at a velocity corresponding to 4 mMol · L⁻¹ blood lactate). Finally (week 8), STEP was repeated in NH and SHAM. Lactate curves were analysed using an Excel based functional data analysis programme (Newell *et al.*, 2006: *Computers in Biology and Medicine*, 36, 262–275), in order to identify the lactate threshold (LT), the velocity preceding a 1 mMol rise in lactate (LT₁), velocities at fixed blood lactate concentrations (2 and 4 mMol · L⁻¹) and Log LT. A paired samples *t* test was used to compare baseline responses in sham *versus* hypoxia. Results are displayed in Table I.

Acutely, NH resulted in a reduced velocity at lactate parameters, with a magnitude of 11.4–16.8% (1.6–2.3 km/h), depending on the method used to define threshold. Following training in NH, this difference appears to be reduced to 2.1–12.6%, indicating acclimation to NH and improved physiological responses in SHAM conditions.

HPHP3-39

The effects of a cycling-specific warm-up on simulated 4-km cycling time-trial performance in the heat (35°C)

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Table I. Baseline responses and adaptation following 6 weeks of training in NH or SHAM conditions.

	2 mMol · L ⁻¹	4 mMol · L ⁻¹	LT ₁	LT	Log LT
Baseline response ($n = 8$):					
SHAM condition (km · h ⁻¹)	16.0 ± 1.0	17.8 ± 0.7	16.4 ± 0.7	16.1 ± 0.6	15.6 ± 0.7
NH condition (km · h ⁻¹)	13.7 ± 0.7*	15.6 ± 0.8*	14.2 ± 0.6*	14.4 ± 0.9*	14.0 ± 0.9*
% difference	-16.8%	-14.1%	-15.5%	-11.8%	-11.4%
SHAM group, post-training ($n = 4$):					
SHAM condition (km · h ⁻¹)	15.5 ± 0.6	17.3 ± 0.5	15.8 ± 0.5	15.7 ± 0.4	15.5 ± 0.4
NH condition (km · h ⁻¹)	13.2 ± 1.0	15.6 ± 0.7	13.9 ± 0.4	14.5 ± 0.9	13.7 ± 1.0
% difference	17.4%	10.9%	13.7%	8.3%	13.1%
NH group, post-training ($n = 4$):					
SHAM condition (km · h ⁻¹)	16.8 ± 0.9	18.8 ± 1.1	17.0 ± 0.7	16.5 ± 0.2	14.7 ± 0.8
NH condition (km · h ⁻¹)	15.7 ± 1.9	16.7 ± 0.5	16.1 ± 1.5	14.7 ± 1.0	14.4 ± 1.1
% difference	7.0%	12.6%	5.6%	12.2%	2.1%

Note: *Denotes a significant difference from normoxic condition ($P < 0.05$).

Heat stress reduces the capacity to perform self-paced, moderate duration, high intensity exercise in the heat (35°C) (Altareki *et al.*, 2006: *Medicine and Science in Sports and Exercise*, 38, S354). Warm-up strategies which lead to increases in body temperature prior to exercise may therefore have detrimental effects on the performance of such modes of exercise in the heat. Few researchers to date nevertheless have evaluated the effects of warm-up on the thermoregulatory response to such modes of exercise in the heat. The aim of the present therefore was to evaluate the effects of a cycling specific warm-up on 4 km time-trial performance in the heat (35°C). Ten male cyclists [mean \pm s: age 33, $s=7$ years, maximal oxygen uptake 58.8, $s=5.7$ ml \cdot kg⁻¹ \cdot min⁻¹) completed a simulated 4-km cycling time trial in laboratory ambient temperatures of 35°C (RH 60%, air velocity 5.6 m/s) following a 20-min cycling specific warm-up (WU) and pre-exercise rest (NWU). Mean performance time was not significantly different between NWU (374.3 \pm 11.5 s) and WU (373.4 \pm 18.6 s) conditions (95% CI of difference = 1.5 to -4.2 s; $P=0.86$). Oesophageal temperature, total sweat loss and RPE were greater in the WU condition compared with NWU ($P < 0.05$). Muscle temperature was also significantly elevated at the onset (WU, 38.8 \pm 0.4°C *versus* NWU, 36.8 \pm 0.6°C) and cessation (WU, 39.9 \pm 0.4°C *versus* NWU, 39.1 \pm 0.6°C) of the 4 km time trial following WU compared with NWU ($P < 0.01$). Blood lactate and ammonia concentrations were elevated at the onset of exercise following WU compared with NWU ($P < 0.05$). Mean skin temperature, mean body temperature, plasma, glucose and potassium, HR, oxygen uptake, serum prolactin and thermal comfort were not significantly different between conditions. These results demonstrate that an increase in the thermal and metabolic load following completion of cycling specific-warm-up does not reduce the capacity to perform self-paced, moderate duration high intensity in the heat.

HPHP3-40

Strength and conditioning practices in rowing

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There is minimal research on the practices of strength and conditioning coaches in England. Information about training programme design could be useful in developing models of good practice and ecologically valid intervention studies. The aim of

the research was to quantify the training practices of coaches responsible for the strength and conditioning of rowing athletes.

A questionnaire was developed and consisted of six sections: (a) personal details, (b) physical testing, (c) strength/power development, (d) flexibility development (e) unique aspects of programme and (f) any further relevant comments regarding the athletes prescribed training programme.

Twenty two rowing and ten strength and conditioning coaches with an average of 10.5 \pm 7.2 years experience agreed to complete the questionnaire. Approximately, 34% coached Olympic standard rowers, 34% national standard, 3% regional, 19% club, and 10% university standard rowers.

All coaches agreed that strength training enhanced rowing performance and the majority (74%) indicated athletes strength trained 2–3 times a week. Most coaches (94%) reported their rowers performed strength training, with 81% using Olympic lifting, and 91% employing a periodised training model. The clean (63%) and squat (27%) were rated the most important exercises prescribed within the training programme. Approximately 50% of coaches used plyometrics such as depth jumps, box drills and standing jumps. Ninety four percent indicated they conducted physical testing on their rowers, typically assessing cardiovascular endurance (80%), muscular power (70%), muscular strength (70%) and anaerobic capacity (57%). On average, testing was conducted by coaches in pre-season (88%) and in-season (91%), while only 31% performed post-season testing. Coaches typically prescribed static stretching (97%), dynamic stretching (69%), PNF stretching (56%).

This research provides detailed information on the current strength and conditioning provision in rowing within Great Britain. Future studies could use this information to develop experimental protocols to examine the effect of current or new strength and conditioning interventions on rowing performance.

HPHP3-41

Alterations in muscle characteristics following continuous and intermittent bouts of exercise

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There is a great deal of literature examining what effect training interventions have on physiological systems. A majority of the work conducted in this area has focussed on $\dot{V}O_{2max}$ and cardiovascular adaptations.

Although it is well proven that intermittent exercise provides a potent stimuli for physiological adaptations to occur over a shorter time period than that of low intensity continuous training, the reasons why and also why individuals respond differently is less well understand.

The aim of this study was therefore to monitor muscle contractile characteristics *in vivo* immediately following two distinct exercise sessions to assess peripheral changes in muscle performance between an acute intermittent and continuous exercise session conducted at the same average intensity.

Eighteen healthy recreationally-active males, mean age 25.1 ± 4.5 years, weight 81.6 ± 9.8 kg and height 1.83 ± 0.6 m participated in the study.

All participants completed three exercise sessions. The first session was for the collection of muscle contractile characteristics (MCC) whilst in a rested state. MCC consisted of both voluntary (maximal voluntary isometric contractions (MVIC)) and electrically stimulated contractions. Electrical stimulation allowed the collection of force frequency data (FFR), rate of force development (RFD) and relaxation ($RR_{1/2}$) and muscle fatigue characteristics. An incremental test to exhaustion was conducted for the determination of the workloads for subsequent exercise interventions. Sessions 2 and 3 consisted of participants completing either a continuous or intermittent exercise session with intensities based on the results of the incremental test. In both sessions the same average work was completed. Immediately following each exercise intervention MCC testing was completed with this data subsequently compared to rested data collected in session 1.

Results showed that both voluntary and electrically stimulated contractions were significantly reduced following intermittent compared to continuous exercise. This manifested itself in a reduction in MVIC, RFD, $RR_{1/2}$ and FFR response ($P < 0.05$). There was no difference in low frequency fatigue between the interventions but there was evidence of high frequency fatigue following the intermittent session.

The findings from this study highlight the physiological strain imposed on the peripheral musculature during two forms of exercise training. It is clear that although both sessions were completed at the same average intensity, intermittent exercise caused a greater reduction in contractile performance. The application of these findings could help us better

understand the training stimulus on peripheral muscle during various exercise interventions and the adaptations in contractile performance following chronic interventions.

HPHP3-42

Grip strength in UK school children

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Aerobic performance is declining in children and adolescents but global anaerobic performance has remained relatively stable for a several decades (Tomkinson, 2007: *Scandinavian journal of medicine & science in sports*, 17, 497–507). Poor handgrip (HG) strength is associated with low muscle and bone mass in adolescents (Chan *et al.*, 2008: *Osteoporosis International*, 29) and metabolic syndrome in adulthood. The aims of the present study were to compare HG values in 11–15 year old schoolchildren with normative data and to investigate between-group differences by age and sex.

Following ethical approval 1339 boys and 1242 girls were tested as part of the ongoing East of England Healthy Hearts Survey. Mass and stature were measured. Grip strength of the dominant hand was measured in Newtons by taking the highest value from three trials using an adjustable handgrip dynamometer (Takei Ltd. Japan).

Age- and sex-specific z-scores were generated for mass and stature using the 1990 UK growth reference curves (Cole *et al.*, 1995: *Archives of disease in childhood*, 73, 17–24). Grip strength z-scores were also generated (Hager-Ross and Rosblad 2002: *Acta Paediatrica*, 91, 617–625). Between-group differences by sex and age were analysed using two-way analysis of covariance controlling for mass and stature. A value of $P < 0.05$ was considered significant after adjusting for collinearity and clustering.

There was a significant main effect for age ($F = 147.9$, $P < 0.0001$), HG z-score declined in both sexes after age 12. There was no main effect sex ($F = 0.8$, $P > 0.05$) but there was a significant age by sex interaction ($F = 5.6$, $P < 0.0001$).

Table I. Marginal estimated mean (standard error) dominant HG z-score corrected for relative mass and stature.

	11–11.9 Years	12–12.9 Years	13–13.9 Years	14–14.9 Years	15–15.9 Years
Boys	0.358 (0.077)	0.947 (0.056)	−0.063 (0.070)	−0.471 (0.066)	−0.473 (0.082)
Girls	0.494 (.070)	0.594 (.049)	0.002 (.063)	−0.437 (0.062)	−0.637 (0.093)

These are the first data to compare a large sample of English schoolchildren's HG strength with published norms. Relative HG was higher norms at age 11 and 12 but steeply declined thereafter. Values were well below published norms in both age 15 in both sexes but more so in girls. The reasons for such differences require further investigation.

HPHP3-43

A comparison of physiological and anthropometric characteristics of regional and national junior rugby league players

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Rugby League (RL) players have well developed physiological capacities, with players requiring high levels of aerobic fitness, speed, muscular power, and agility, due to the physical nature of the game (Gabbett, 2005: *Journal of Sports Sciences*, 23 (9), 961–976). A testing battery that assesses these components of fitness can be used to compare physiological and anthropometric characteristics of different playing levels and if differences are observed, results could be used as a component for talent identification or selection. The aim of this study was to investigate the physiological and anthropometric characteristics of junior RL players and to determine if any differences exist between regional and national level players.

With institutional ethics approval, 90 junior (under 14) male RL players (Regional, $n=68$, Age mean 14.6, $s=0.3$ years; National, $n=22$, Age mean 14.6, $s=0.3$) underwent anthropometric measurements (stature, body mass and sum of four skinfolds) and assessments of speed (10, 20, 30 and 60 m sprint), agility (505 – turning on left and right foot), muscular power (vertical jump and 2 kg seated medicine ball chest throw) and estimated maximal oxygen uptake (20 m MSFT). Differences in regional and national levels were compared using a one-way analysis of variance.

This was the first study in the UK to identify physiological and anthropometric characteristics of regional and national junior RL players. The results are consistent with the findings by Gabbett *et al.* (2007: *Journal of Strength and Conditioning Research*, 21 (4), 1126–1133) that physiological and anthropometric characteristics did not differentiate between successful and less successful adult Australian RL players. The lack of discrimination between regional and national level players in terms of anthropometry

Table I. Physiological and anthropometric characteristics (mean \pm s).

	Regional	National
Stature (cm)	175.97 \pm 5.86	175.07 \pm 7.28
Body mass (kg)	71.71 \pm 11.31	72.58 \pm 6.95
Sum of four skinfolds (mm)	42.05 \pm 17.81	39.57 \pm 14.00
10 m speed (s)	1.88 \pm 0.10	1.86 \pm 0.08
20 m speed (s)	3.23 \pm 0.15	3.21 \pm 0.16
30 m speed (s)	4.51 \pm 0.23	4.48 \pm 0.24
60 m speed (s)	8.39 \pm 0.48	8.38 \pm 0.52
Agility (s)		
Right	2.50 \pm 0.13	2.46 \pm 0.08
Left	2.53 \pm 0.14	2.45 \pm 0.08*
Vertical jump (cm)	39.35 \pm 4.79	41.09 \pm 5.27
Medicine ball throw (cm)	5.92 \pm 0.58	6.03 \pm 0.55
MSFT (ml \cdot kg ⁻¹ \cdot min ⁻¹)	49.01 \pm 5.19	50.43 \pm 3.38

Note: *Significantly different compared with regional ($P=0.024$).

and physical attributes suggests it is potentially differences in other factors, such as skill characteristics and games playing ability, that are associated with selection to the national squad, which is consistent with the aims of the RFL performance pathway.

HPHP3-44

Relative age effect and maturational differences among playing positions in high performance junior rugby league players

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Relative Age Effects (RAEs), reflecting observed inequalities in participation and selection as a result of annual age-grouping, are a common problem in most team sports (e.g. soccer; Musch & Grondin, 2001: *Developmental Review*, 21, 147–167). In junior representative Rugby League, RAEs increase with each performance level with coaches preferentially selecting taller, heavier and earlier maturing players. However, the effect of playing position on RAEs is not clear with limited data available as to whether maturational differences exist between playing positions in youth sport. Therefore the purpose of this study was to examine the RAE and maturational status amongst playing positions in high performance junior Rugby League players.

With institutional ethics approval, 683 regionally (e.g. Yorkshire) selected players (Age mean 14.57, $s=0.83$ years) underwent anthropometric testing between 2005 and 2007. Birth date, playing position,

height, sitting height and body mass were obtained, and age at Peak Height Velocity (PHV) calculated (Mirwald *et al.*, 2002: *Medicine and Science in Sport and Exercise*, 34, 689–694) for each player. Player's birth dates were recoded by quartile (e.g. Q1 = September–November, Q2 = December–February, etc.) with playing position categorised into one of four subgroups ("Outside-Backs", "Halves and Hookers", "Props" and "Backrowers").

Chi square analysis identified significant uneven birth date distributions ($\chi^2 = 236.36$, $P < 0.01$) for all Regional players and each playing position. Odds ratio (OR) and 95% Confidence Intervals (CI) identified increased risk of selection (Q1 v Q4 OR: 13.39, 95% CI: 4.32–41.53) for the "Prop" position, with 82.9% of "Props" born in the first half of the selection year. One way analysis of variance identified significant ($P < 0.01$) differences in maturity, height and body mass between positions with "Props" and "Backrowers" significantly taller, heavier and earlier maturing than the "Outside-Backs" and "Halves and Hookers".

Whilst recognising the physical demands of Rugby League, findings demonstrate that player selection at junior representative levels is significantly biased towards the relatively older player, with "Props" and "Backrowers" older, earlier maturing, taller and heavier than "Outside-Backs" and "Halves and Hookers". Thus, younger and later maturing junior players, especially "Props" and "Backrowers", may be disadvantaged in selection to Regional squads due to a lack of physical development, highlighting issues related to differences between selection for current performance and talent identification and development.

HPHP3-45

Effects of a 12 week intervention training programme on shoulder function in university rugby union players

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Background. Shoulder injuries within rugby union are amongst the injuries causing the greatest number of days absence, with poor rotator cuff muscle strength and increased shoulder laxity being associated with shoulder injury (Cheng *et al.*, 2007: *British Orthopaedic Association Annual Congress*, Manchester).

Purpose. To investigate the effect of a shoulder intervention training programme on isokinetic shoulder strength and gleno-humeral joint laxity.

Methods. Following institutional ethical approval, 21 male university (1st XV) rugby union players were randomly assigned to an intervention (INT, $n = 10$) or control (CON, $n = 11$) group. The INT group (mean age 19.6 years, $s = 1.5$) performed a 12 week shoulder training programme in addition to their normal training while CON (20.5 years, $s = 1.3$) conducted their normal training only. Iso-kinetic dynamometer shoulder strength (at 60°/s and 120°/s) and gleno-humeral joint laxity (via Ultrasound) were measured in all participants before and after the intervention period. Mixed between-within participants ANOVA assessed any interaction effects over the time period (pre *versus* post) between INT and CON.

Results. Internal rotation peak torque at 60°/s increased in INT (49.2 NM, $s = 8.0$ *versus* 52.6, $s = 6.0$) but decreased in CON (57.6, $s = 10.7$ *versus* 52.0, $s = 11.1$; interaction effect $P = 0.002$, Partial η^2 0.42), with similar findings for peak torque at 120°/s (INT: 48.2, $s = 8.6$ *versus* 50.3, $s = 5.0$; interaction effect $P = 0.02$, Partial η^2 0.26). There was no significant interaction effect for external rotation peak torque at 60°/s or 120°/s. Anterior, inferior and posterior gleno-humeral joint translation (laxity) did not change significantly in either INT or CON with no interaction effect.

Discussion. The ability of the shoulder intervention training programme to increase internal rotation shoulder strength in INT compared with CON supports previous research findings (Ide *et al.*, 2003: *Journal of Shoulder and Elbow Surgery*, 12(4), 342–345). However, no link has been established between increasing strength and reduced joint laxity scores, somewhat contradicting findings previously observed by Jansson *et al.* (2005: *Scandinavian Journal of Medicine and Science in Sports*, 15, 169–176).

Conclusion. The shoulder training programme was able to improve strength measures but not passive laxity. How these changes related to dynamic function requires further investigation.

HPHP3-46

Semi-automated time-motion analysis of senior elite rugby league

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An accurate analysis of the movement patterns of players during games is a pre-requisite for developing sport-specific training programmes (Meir *et al.*, 2001: *Strength and Conditioning Journal*, 23, 42–46). To date, only Meir *et al.* (2001) has reported time-motion data from elite rugby league matches, though the data were generated from subjective analyses of players' gaits. Recent developments in semi-automated time-motion analysis systems provide the potential to generate valid and detailed movement characteristics during match play (Di Salvo *et al.*, 2006: *International Journal of Performance Analysis in Sport*, 6, 108–119). Accordingly, this paper presents selected time-motion data from senior elite rugby league matches produced by the ProZone 3 image recognition tracking system (ProZone[®], Leeds, England).

Following ethical approval by a university research ethics committee, the ProZone system was used to track the movements of 78 players during three full matches. Players were categorised as outside backs ($n=30$), pivots ($n=18$), props ($n=12$) or back row ($n=18$). Mean total distance covered and work-to-rest ratios (W:R) for ball in play, ball out of play, attacking and defending were computed and compared across playing positions via a Kruskal-Wallis test (Table I).

Significant ($P < 0.05$) positional main effects on distance covered, ball in play and defending W:R were observed. The outside backs were notably the least active in that they covered the shortest distance, and had the highest ball in play, ball out of play and defending W:R. Conversely, prop and back row players covered a greater distance and engaged in more work (both defending and attacking) than other positions.

The current data represents the most comprehensive and precise analysis of the positional movements of senior elite rugby league players thus far and can be used to aid the prescription of rugby-specific training.

HPHP3-47

Response to a structured exercise programme for Huntington's Disease; a single case study

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Huntington's Disease (HD) is a hereditary, degenerative disorder of the basal ganglia. The progressive loss of nerve cells results in debilitating symptoms that include random, uncoordinated movement (chorea), loss of balance and impaired cognition. The effects of structured physical exercises on people with HD has yet to be established, however previous studies in other neurological conditions have reported improved motor control and fitness levels following regular exercise. The purpose of this study was to explore the feasibility of delivering cardiovascular (CV) and resistance exercises designed to modify mobility, balance, strength, and exercise capacity to a person with HD.

Following institutional ethical approval a 39 year old female, 74 kg; 157.3 cm with confirmed HD attended 14 training sessions over 7 weeks. Functional measures of balance (Berg balance scale), maximum voluntary contraction of the knee extensor and flexor muscle groups, the Timed Up and Go Test, self reported falls occurring in the previous 30 days and a physical activity questionnaire (IPAQ-LF), were recorded at session 1 and repeated at the end of the training period.

CV exercise was performed on a recumbent cycle with the upper-body strapped to the backrest, feet secured with toe clips and straps. The cranks were turned manually until unassisted pedalling was maintained. Uninterrupted pedalling was achieved at session 6. Thereafter, sprint

Table I. Mean \pm s for total distance covered (m) and W:R.

Players	Total distance covered (m)	W:R			
		Ball in play	Ball out of play	Defending	Attacking
Outside Backs	8142 \pm 630	1:8.2 \pm 1.6	1:101.5 \pm 114.6	1:9.3 \pm 3.4	1:7.9 \pm 1.6
Pivots	8800 \pm 581*	1:7.0 \pm 1.6*	1:68.0 \pm 46.1	1:6.2 \pm 1.9*	1:8.6 \pm 2.4
Props	8688 \pm 405*	1:5.7 \pm 1.0*	1:83.3 \pm 41.0	1:4.8 \pm 1.2*	1:7.2 \pm 1.3
Back row	8685 \pm 547*	1:5.5 \pm 0.9*	1:79.8 \pm 20.4	1:4.5 \pm 1.0*	1:7.2 \pm 1.1

Note: *Significantly different ($P < 0.05$) to outside backs.

training and incremental increases to flywheel resistance were introduced to improve pedaling technique.

Lower-body strength exercises were performed on a seated leg-press. Sit to stand exercises were performed from a bench. Functional core stability and upper-body exercises involved double-arm pull-downs, double-arm lateral raises and single-arm rotations all performed on a cable resistance machine while standing.

Cycling capacity progressed from 4 × 5 min exercise periods at session 1 to a peak of 1 × 47 min continuous (6 miles) at session 10. Maximal pedaling cadence progressed from 55 to 101 rpm. Heart rate (HR) was maintained within 55–85% of predicted HR_{max}. Rating of Perceived Exertion was variable and at variance with that expected for a given HR. Resistance exercises progressed for all muscle groups. The functional tests were conducted by an independent assessor who observed improvements in strength and balance, self reported physical activity and self reported falls with no adverse side effects.

The positive outcome to a structured 7 week exercise programme in this single case study warrants further investigation into exercise interventions for people with HD.

HPHP3-48

Impact of circulating angiotensin II concentration on post-exercise haemodynamics in pre-hypertension

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A single bout of dynamic exercise induces profound changes in the mechanisms that regulate and determine arterial pressure, resulting in a post-exercise hypotension (PEH) that lasts for up to 2 h in sedentary individuals but can also persist for up to 13 h in hypertensive participants. It is generally accepted that PEH is resultant from a persistent rise in peripheral vascular conductance that is not completely offset by increases in cardiac output. At the level of the vascular endothelium both adrenergic and nonadrenergic vasoconstrictor pathways play a regulatory role in normal vascular function. The overall effect on haemodynamics and arterial pressure will be determined by how these various pathways and mechanisms integrate at the level of the vascular smooth muscle and endothelium. Therefore, using an acute bout of dynamic exercise

Table I. Haemodynamic and metabolic responses to sub-maximal cycle exercise.

Stage	SVR (RU)	Angiotensin II (pmol/l)
Pre	17.4 ± 4.5	25 ± 4
Post	12 ± 3.9*	28 ± 4*
P1	15 ± 3.9**	32 ± 6*
P2	15.8 ± 3.8**	27 ± 7

Notes: RU, resistance units.

**P* < 0.05 *v* Pre.

***P* < 0.05 *v* Post.

the present study sought to determine angiotensin II-mediated regulation of post-exercise haemodynamics in pre-hypertensive men.

Following institutional ethical approval nine pre-hypertensive males, mean arterial pressure = mean 106, *s* = 5 mmHg (mean 50, *s* = 10 years), not on medication, were studied following 30 min of cycle exercise at 60% maximal oxygen consumption. The participants were followed post-exercise for 2 h. Systemic mean arterial pressure (MAP) was determined by sphygmomanometry at all time points. Left ventricular haemodynamics were assessed via echocardiography and systemic vascular resistance (SVR) determined by the quotient of MAP and *Q*. Peripheral venous blood was sampled from an antecubital vein pre-, immediately post-, 1-hour post- (P1) and 2-hours post- (P2) exercise and values corrected for plasma volume shifts. Angiotensin II (Ang II) concentrations were determined in venous plasma, following an extraction procedure, via a double-antibody radioimmunoassay.

Exercise decreased SVR whilst concomitantly elevating Ang II concentration (Table I).

The results of the present study indicate that PEH ensues in the presence of increased Ang II. Whether changes in Ang II receptor sensitivity are obligatory for PEH requires further investigation. Although, it appears that a powerful vasodilatory mechanism exists, capable of overriding a strong vasoconstrictor signal, mediating the exercise-induced hyperaemia present during PEH.

HPHP3-49

The effect of cycling intensity on corticospinal excitability in a person with Multiple Sclerosis: A pilot study

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Multiple Sclerosis (MS) is a progressive, relapsing-remitting degenerative disease of the central nervous system (CNS). Inflammatory damage to myelin results in slowed or disrupted nerve conduction leading to physical and cognitive disability. Physical exercise has been shown to improve fitness, mobility, functionality and quality of life in people with MS (pwMS). However, the intensity of exercise that is best tolerated and offers the most positive health outcome has yet to be established.

The purpose of this pilot study was to investigate CNS responses to 20 min of cycling exercise at two different intensities in a person with MS. We used transcranial magnetic stimulation (TMS), a non-invasive method for exploring central pathways, to measure corticospinal excitability before and after the exercise intervention.

Following institutional ethical approval a 59 year old male with confirmed MS agreed to participate. The exercise tests were preceded by a graded exercise tolerance test (ETT) performed to volitional fatigue on a friction-braked cycle ergometer. The participant attended a further two sessions where he was required to lie on a bed for 20 mins while five single pulses of TMS were administered at 5 min intervals. He then performed 20 mins cycling exercise at 45% (T45) or 60% (T60) of maximum ETT workload before returning to the lying position on the bed. TMS was administered within 30 s of completion and repeated at 2, 4, 6, and 8 min. MEPs were recorded from electrodes placed on the left rectus femoris (RF). The experiment was conducted at 120% of pre-determined threshold.

MEP amplitudes were measured from baseline to peak and visually examined for general trends. T tests were used to determine differences between pre- and post- T45 and T60 data. Significance was accepted at $P < 0.05$.

There was no difference in the pre-T45 and pre-T60 MEP amplitudes ($P = 0.65$), or the pre- and post-exercise data during T45 ($P = 0.78$). However, post-T60 MEP amplitudes were significantly depressed ($P \leq 0.01$) and a significant difference existed between post-exercise T60 and T45 ($P \leq 0.01$).

This study found that MEP amplitudes were significantly depressed after exercising at 60%, but not at 45% of the maximum ETT workload. The results suggest that exercising at 45% ETT may be better tolerated in pwMS, however further tests incorporating physiological and autonomic markers are required before health benefits can be established. Further study with more participants is warranted to determine the effects of exercise intensity in people with MS.

HPHP3-50

Training response to a generic rowing training programme: A case study of an elite lightweight female rower

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International rowing is raced over 2000 m, which for lightweight women (LW), takes 7–8 min. A case study was conducted on a LW rower who progressed from club to elite level over a 3 year period.

Between March 2005 (baseline) and March 2008, the athlete (female, 26 years) followed a generic training programme of which approximately 90% was spent below, and 10% above a blood lactate concentration ([LA]) of $2 \text{ mMol} \cdot \text{L}^{-1}$. On eight occasions, the athlete attended the laboratory for a sub-maximal incremental rowing step test and a maximal ramp test. The step test comprised 6×4 min efforts of increasing intensity, with 30 s rest. After baseline testing, work rates were fixed for all future tests. Oxygen uptake was measured by expired air collection during the final minute of each step (closed circuit method) and whole blood [LA] was measured from an ear lobe capillary sample (Analox GM7, Analox, UK) taken during the rest period. Measurement of $\dot{V}O_{2\text{max}}$ was undertaken during the ramp test to volitional exhaustion.

Results show that from baseline to October 2007, both $\dot{V}O_2$ and [LA] fell at the given submaximal workrates. $\dot{V}O_{2\text{max}}$ increased ($2.96\text{--}4.04 \text{ L} \cdot \text{min}^{-1}$) and power output during 3×6 km ergometer rowing increased ($165\text{--}180 \text{ W}$). This corresponded with a 22 s improvement in 2000 m ergometer time. Between October 2007 and March 2008, no further changes in physiological or performance markers were observed.

The physiological changes observed between baseline and October 2007, occurred as the athlete adapted to the stimulus presented by the generic training programme. However, further improvements were not observed between October 2007 and March 2008. This would suggest that: (i) the generic programme was no longer providing the appropriate stimulus for adaptation, (ii) the athlete was suffering from unexplained underperformance syndrome or (iii) the athlete had reached full potential.

It is unlikely that a generic training programme will elicit the full athletic potential from all those athletes following it. Therefore, when elite athletes on generic programmes exhibit prolonged plateaus, the prescription of training intensities and volumes based upon individualised test results may be a more

effective option in cases (i) and (ii), above. Despite the resource implications of individualising training programmes for groups of elite athletes, the improvements in performance this could elicit may prove cost-effective.

HOTP4-01

Determinants of the level of physical activity of the adolescents of Madrid

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The attitude towards health during adolescence has a powerful influence on both the health of the adolescent and the future health of adult. Much evidence exists regarding the risk of a sedentary lifestyle in the development of some illnesses. The purpose of this study was to investigate the relationships between the level of physical activity (PA) of the adolescents (13–17 years old) of Madrid and various bio-psycho-social variables.

Two hundred and sixty six boys and 288 girls between 13 and 17 years old were selected from 35 educative centres belonging to 16 of the 21 districts of Madrid. After obtaining a written consent of the parents the participants completed a survey containing the Modifiable Activity Questionnaire for Adolescents (Aaron & Kriska, 1997: *Medicine and Sciences in Sport and Exercise*, 29(6)[Supplement], S79–S82). The participants were then submitted to an anthropometric measurement (Cordente *et al.*, 2007: *Revista Española de Salud Pública*, 81(3), 308–317).

Several variables were associated with PA, namely: gender (χ^2 , $P=0.000$), PA of the father in both boys (χ^2 , $P=0.034$) and girls (χ^2 , $P=0.003$). In girls, PA of the mother (χ^2 , $P=0.007$) and peers (χ^2 , $P=0.022$), SES ($P=0.001$), scholastic performance (χ^2 , $P=0.000$) and body fat (χ^2 , $P=0.007$). In boys tobacco consumption (χ^2 , $P=0.07$). Worrying values (225 min/day \pm 135 for boys and 174 min/day \pm 109 for girls) of screen time (ST) were observed in the majority of the sample. The boys, mainly of the lower SES, were found to have the most disturbing values. Following a logistic regression, the variables that had the greatest influence on the PA were as follows, in order of importance: gender, PA friends, PA of the father and overweight.

The finding that the gender and the PA of friends are the most important determinant of PA, is supported by literature, however the importance of the other variables is not in agreement with all the findings in the literature.

The following proposals for the future were made. Girls and adolescents with lower SES should receive high-priority attention concerning their health-related habits. Parents should be encouraged to practice PA. Nutritional education for children, adolescents and parents is necessary to avoid being overweight and to change sedentary habits.

HOTP4-02

Membership retention in the fitness industry: The development and validation of a predictive model

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Fitness club managers are becoming increasingly concerned with membership retention rates yet there appears to be no empirical research into the factors underlying member attrition i.e. what makes people decide to cancel the membership? Whilst there is a wealth of research into member attendance (exercise adherence) as well as member satisfaction there is little, if any, empirical research which bridges the gap between member attendance and retention. The aim of this article is three-fold. Firstly, to introduce the design of this research project aimed at developing a predictive model of membership retention in fitness clubs. Secondly, to report the findings to date and thirdly, to suggest the managerial implications of this findings.

This PhD research project is mixed-method in design (QUAL-Quan); which began with a qualitative phase. This phase consisted of a literature review followed by telephone interviews conducted with a stratified random sample of gym members ($n=25$). The findings of the interviews were combined with the results of the literature review to identify potential components of a conceptual model of fitness club attendance and retention. Thus, the quantitative phase began. The identified components suggested as underpinning attendance and retention included attitudinal, normative and control beliefs towards attending their fitness club, levels of self-determination towards attending fitness clubs, habitual attendance, social anxiety, social identity, perceived service quality, brand identification and commitment. The Membership Retention Questionnaire (MRQ) was developed to measure the components in this model and firstly “snowballed” to a purposive sample of gym members and secondly distributed to members of one club. This model is subject to further factor analysis and structural equation modelling of the quantitative findings. This research methodology is unique in its application to

researching fitness club retention, due to its sampling of fitness club *members*; not just fitness club *users*, and an upcoming longitudinal analysis (12 months) of the model's value in predicting *actual* membership retention; not just membership *intentions*.

The managerial implications of these findings include the importance of distributing the MRQ to members at various time points throughout their club membership. This allows the measurement of relevant behavioural and psychological factors which can be used to assess "risk" in members and implement effective interventions in order to increase attendance and retention rates.

HOTP4-03

Developing graduate attributes

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Within the thriving economic community, competition within the graduate employment market is rife. At present 88 higher education institutions in the UK between them offer ~ 1500 sport-related degree courses (UCAS, 2007, Retrieved 8th January 2007 from www.ucas.co.uk). This creates huge competition for graduate level jobs within the sport sector. However, it has also been noted that "increasingly, labour market information and skills audits are identifying that graduate trainees in many sectors of the hospitality, leisure, sport, and tourism industries often lack specific technical skills and knowledge" (SPRITO cited in Burlinson, S., Jones, T., & Contwell, J. (2003). *Can adding additional qualifications to an undergraduate programme provide "added value" and improve student's employability within vocational disciplines*. Retrieved 8th February 2006 from http://www.hlst.heacademy.ac.uk/projects/burlinson_report.pdf). Thus, the aim was to investigate the current employability skills of students and how they can be enhanced via curriculum interventions.

Having gained institutional ethical approval, 153 questionnaires and a series of semi-structured focus group interviews exploring perceptions of attributes gained were completed by Level 3 BSc Sport Sciences students. In addition, an audit of graduate attributes within the curriculum took place.

Results revealed generic attributes were prevalent in the programme and that they were aligned with those QAA typically expect a graduate to gain. In line with the audit results, questionnaires and interviews revealed that while graduates felt equipped with skills to enter a variety of jobs (e.g. sales, recruitment), in order to enter the competitive, sport labour market, graduates were required to engage in additional

training. When asked about potential course developments (e.g. career/graduate attribute workshops, additional careers advice, work-based learning) all responded positively.

Based on these findings, teaching and learning interventions to enhance employability in the Level 3 cohort were developed and implemented in the following academic year. These included: (re)induction activities (academic reflection, educational planning, applying for further education); CV writing; employability card sort task; performance profiling; and goal setting. In addition, a careers fair specifically tailored for students graduating with a sport-related degree was organised. Evaluation from a student and staff perspective yielded was very positive. As a result of the findings, the development and validation of a work-based learning module designed to enhance employability skills further is currently underway.

HPHP4-04

Body mass index and waist circumference: Associations with aerobic capacity test performance in English schoolchildren

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Low aerobic capacity, adiposity and central adiposity are cardiovascular disease risk factors that track from childhood to adulthood. Brunet *et al.* (2007: *International Journal of Obesity*, 31, 637–643) found that waist circumference (WC) was associated with aerobic capacity but was not independent of BMI. Conversely, Lee and Arslanian (2007: *European Journal of Clinical Nutrition*, 61, 561–565) found independent associations between WC, BMI and aerobic capacity.

The aim of the present study was to investigate if WC and BMI were independently associated with aerobic capacity test performance in English schoolchildren.

After gaining institutional ethics approval and parental consent, 2717 English schoolchildren (1387 boys) aged 11–16 years were recruited from within a larger ongoing study. WC (cm), BMI ($\text{kg} \cdot \text{m}^{-2}$) and aerobic capacity test performance (20 m shuttle run test, 20 mSRT) were measured and z-scores created using published reference data. Initial regression analysis revealed age to be a significant predictor of 20 mSRT performance. The sample was therefore divided into four groups by sex and age (11–13 years and 14–16 years). The relationship between BMI, WC and 20mSRT z-scores were then analysed by multiple linear

regression (SPSS 14.0 for Windows). A $P < 0.05$ after controlling for clustering indicated statistical significance.

WC and BMI were significant independent predictors of 20mSRT performance in younger boys ($r^2 = 0.138$, $P < 0.05$) and girls ($r^2 = 0.118$, $P < 0.05$). WC was the strongest predictor in both groups. In the older boys only WC predicted 20 mSRT performance ($r^2 = 0.119$, $P < 0.05$) whereas in older girls, this was true only of BMI ($r^2 = 0.050$, $P < 0.05$).

The present study found that BMI and WC were independently, and inversely associated with 20 mSRT performance in younger English schoolchildren (11–13). This agrees with the findings of Lee and Arslanian (2007). In the older boys, WC, which is a measure of central adiposity, was related to 20 mSRT performance but BMI was not. Only a small proportion of the variance in 20 mSRT performance was explained by adiposity in older girls, indicating that other factors may play a stronger role in this group. These are the first data in a large sample of children in this age group. WC and BMI are independently associated with aerobic capacity test performance in younger schoolchildren. In older groups there are between-sex differences in the relationship between adiposity measures and aerobic capacity test performance.

HPHP4-05

Physiological responses during cycle time trials: Variable versus constant power output

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Pacing strategy, the “within race distribution of power output” is an important factor in cycle time-trials. Mathematically, on a flat course with no wind the optimal strategy is to maintain a constant power-output, however, on a course with hills or wind, worthwhile improvements in performance can be gained by systematically varying power output. However, evidence suggests that there are riders who can and those who cannot vary power around a performance threshold. The aim of this study was to identify physiological markers and responses which predict the direction of this ability (AV).

Following ethical approval 18 participants, age 35.4 ± 6.1 years, height 178.9 ± 6.8 cm, mass 74.1 ± 7.9 kg, RMP_{\max} 371 ± 30.2 W, $\dot{V}O_{2\max}$ 4146.9 ± 421.4 ml·min⁻¹, participated in this study. Following familiarisation, participants completed an incremental ramp test to exhaustion and a

30 s Wingate test, four trials of 2–15 min to determine critical power (CP), two 8 min transitions to CP to estimate $\dot{V}O_2$ kinetic parameters, a test to exhaustion at CP (CPT), a freely-paced trial for the same duration as (FPT) and a trial to exhaustion where power was systematically varied $\pm 5\%$ about CP (VPT). Performance trials were conducted using an SRM ergometer (Julich, Welldorf, Germany), and $\dot{V}O_2$ kinetic analysis using a Lode ergometer (Lode Excaliber Sport PFM, Groningen, The Netherlands). Gas exchange was measured continuously breath-by-breath (Oxycon Pro, Jaeger, GrubH, Wuertzburgthe, Germany). Ability to vary power output (AV) was calculated as work done in CPT/VPT $\times 100$. The clinical significance (positive/trivial/negative) of the relationship between this ability and physiological variables was determined using the methods of Hopkins, 2002.

The range of AV was 50.5–139.1% (Mean $91.6 \pm 22.6\%$). Absolute $\dot{V}O_2$ at VT_2 was the most likely predictor of AV ($r = 0.545$, 98/2/0), and RMP_{\max} ($r = 0.513$, 96/3/0); $\dot{V}O_2$ time constant ($r = -0.473$, 1/4/95) and Anaerobic Work Capacity ($r = 0.180$, 62/24/14). Differences in work done and physiological responses between trials were clinically trivial.

These findings indicate that $\dot{V}O_2$ at VT_2 is the most discriminatory factor in identifying AV. Furthermore, around CP intensity, no differences in the measured physiological responses were apparent, regardless of whether power application is constant, varied systematically or when independently controlled by the cyclist.

HPHP4-06

Bi-lateral lower limb muscle activity during a self-paced 40.2-km laboratory cycling time-trial

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Electromyographic techniques have provided useful insight into the activation of specific muscles recruited during laboratory cycling. However, past research has focused solely on uni-lateral measurement, despite the bi-lateral, asynchronous nature of the pedalling action. In addition, the authors are aware of only one previous investigation where power output was freely chosen by the participant, more closely replicating actual road cycling performance (Duc *et al.*, 2005: *International Journal of Sports Medicine*, 26, 145–150). Therefore, the study aim was to explore bi-lateral lower limb

electromyographic activity during a self-paced 40.2 km laboratory cycling time-trial.

Following ethical approval, six male competitive time-trial cyclists (PPO 374.1, $s = 25.1$ W, $\dot{V}O_{2\max}$ 4.27, $s = 0.3$ L·min⁻¹) completed a 40.2-km time-trial on a Kingcycle ergometer (Kingcycle Ltd., High Wycombe, UK). Using the procedure described by Moritani *et al.* (1986: *Journal of Applied Physiology*, 60, 1179–1185), bi-lateral muscular activity from the vastus medialis (VM), vastus lateralis (VL) and biceps femoris (BF) was recorded for 10 s every 5 min from the commencement of the time-trial. Myoelectric activity was quantified using root mean square (RMS) of three consecutive contractions within each 10 s period. Amplitudes were normalised and expressed as a percentage of the 5th minute value (Duc *et al.*, 2005: *International Journal of Sports Medicine*, 26, 145–150).

Performance variables for the time-trial were; time mean 56:11, $s = 1:44$ min:sec; power output mean 272.8, $s = 22.1$ W; heart rate mean 167, $s = 14.4$ beats·min⁻¹. Significant bi-lateral differences emerged in the BF activation level (left 97 *versus* right 84.9%, $P = 0.049$). Significant uni-lateral differences were found in the left leg between the BF and VL (97 *versus* 82.7 %, $P = 0.029$) and BF and VM (97 *versus* 79.4 %, $P = 0.008$). Mean RMS decreased significantly from the 5th minute to the end of the time-trial for the right BF (–22.4%, $P = 0.037$), left VL (–23.8%, $P < 0.001$) and left VM (–31.7%, $P = 0.01$).

Through simultaneous measurement of activity in selected muscles of the left and right legs, bi-lateral differences in the levels of activation (and how these levels change over time) have been found over the course of a 40.2 km time-trial. It is suggested that future EMG analyses of the cycling pedalling action should collect bi-lateral data whenever possible.

HPHP4-07

Facial EMG as a psychophysiological measure of effort during physical tasks

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Rating of perceived exertion (RPE) is a subjective measure commonly used to assess effort during physical tasks. However, self-reported measures like RPE may be biased by psychological factors such as self-presentation (Boutcher *et al.*, 1988: *Journal of Sport & Exercise Psychology*, 10, 270–280). Therefore, an objective measure of perceived exertion is desired. Electromyography (EMG) of certain facial muscles has

been used as an index of effort during mental tasks (i.e. Van Boxtel & Jessurun, 1993: *Psychophysiology*, 30, 589–604), but not during physical tasks. We therefore investigated the validity of facial EMG as an objective measure of effort during physical tasks.

After departmental ethical approval, 20 male participants (Age mean 22, $s = 1.8$ years) were recruited to perform unilateral leg-extensions with their dominant leg. After establishing one repetition maximum (1RM), participants were randomly assigned to two groups (treatment and control). During the pre-test session, both groups performed three single leg-extensions at 20%, 40%, 60% and 80% 1RM in a random order with 2 minutes rest between lifts. After a minimum of 48 hours, participants in the treatment group repeated the leg-extension protocol after performing a 100 drop-jump protocol known to induce a significant 20% strength loss without metabolic stress or changes in muscle receptor sensitivity (Marcora *et al.*, 2008: *AJP – Regulatory, Integrative and Comparative Physiology*, 294, R874–R883). Participants in the control group repeated just the leg-extension protocol. During each lift, EMG amplitude of the corrugator supercilii, the procerus and the depressor supercilii was measured bilaterally, whilst perceived exertion was rated immediately after each lift using the Borg CR-10 scale.

Three-way mixed ANOVAs revealed that both facial EMG amplitude and RPE increased with increasing load (main effects $P < 0.001$, effect sizes *partial* η^2 0.51 and 0.94) and with muscle fatigue (test \times group interactions $P < 0.05$, effect sizes *partial* η^2 0.24 and 0.47) in the treatment group compared to control. Individual correlations between facial EMG and RPE were high (average Spearman's $\rho = 0.75$).

Facial EMG amplitude is a valid objective measure of effort during physical tasks as it changes with increasing loads and muscle fatigue, and correlates with RPE. Further studies are necessary to experimentally test the hypothesis that this psychophysiological measure of perceived exertion is not affected by self-presentation bias.

HPHP4-10

Physiological characteristics of elite boulderers

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Bouldering involves completing short climbing tasks performed at a low height that do not require the use of ropes for safety. Climbing is an Olympic Demonstration Sport, and bouldering is becoming the most popular discipline of climbing due to its accessibility, its audience friendly visual impact, and

its reduced risk compared to traditional roped (lead) climbing. However, the physiological requirements of bouldering are unknown. Therefore, the purpose of this study was to characterise elite boulderers, and compare them to appropriate control participants.

Following institutional ethical approval, 12 boulderers (BS) (age mean 25.3, $s=4.9$ years; height mean 177.7, $s=4.9$ cm; body mass mean 70.2, $s=6.2$ kg) of elite level (regularly climbing at Fontainebleau grade 7b) were matched (± 5 years; ± 5 cm) to 12 active controls (CON) from non-upper body dominant sports. Body composition was assessed by dual energy X-ray absorptiometry. Strength and power endurance were assessed via a number of isometric tests, including grip strength, climbing specific finger strength, shoulder girdle and trunk endurance, isometric leg lift, and tolerance to forearm fatigue. Differences between groups were analysed by independent t test.

Fat mass and lean mass were not different between groups, but BS possessed greater forearm bone density (BS *versus* CON: mean 1.12, $s=0.12$ *versus* 0.98, $s=0.11$ g·cm⁻³, $P=0.015$, $d=1.1$). Boulderers showed greater (absolute) climbing specific finger strength and greater (relative to body mass) hand and climbing specific finger strength (e.g. BS *versus* Con: absolute finger strength mean 50.4, $s=6.9$ *versus* 39.1, $s=8.5$ kg, $P=0.003$, $d=1.5$). Climbers also possessed greater shoulder girdle endurance (BS *versus* CON: bent arm hang time mean 58.5, $s=13.4$ *versus* 39.9, $s=10.5$, $P=0.002$, $d=1.6$). In contrast, no differences were observed for leg lift, trunk endurance measures, or forearm fatigability (P all > 0.124).

Elite boulderers have high forearm bone density, and are adapted to the demands of climbing with high grip and finger strength relative to body weight, and high shoulder girdle endurance. In contrast to previous studies on lead climbers, boulderers are not resistant to developing forearm fatigue. These characteristics may reflect the physiological demands of bouldering, being upper body dominant, and of higher intensity but shorter and more intermittent duration than lead climbing.

HPHP4-11

Longitudinal changes in the $\dot{V}O_2$ kinetic response to heavy-intensity exercise in adolescent boys

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A recent investigation in prepubertal children showed a slower phase II $\dot{V}O_2$ response and larger $\dot{V}O_2$ slow component over a 2-yr period during heavy-intensity exercise (Fawcner & Armstrong, 2004). This is consistent with an age-dependent change in the muscles potential for O_2 utilisation. However, data on the $\dot{V}O_2$ kinetic responses of children during adolescence are relatively sparse. Therefore, the aim of this study was to investigate longitudinal changes in the $\dot{V}O_2$ kinetic response to heavy-intensity exercise in adolescent boys.

With institutional ethics approval, 10 healthy boys (mean age 14.2, $s=0.3$) completed exercise testing on two occasions with a 2-yr interval. Participants completed four step change transitions, from unloaded pedalling to a constant work rate corresponding to 40% of the difference between the $\dot{V}O_2$ at V-slope and peak $\dot{V}O_2$ (40% Δ). Each participant's breath-by-breath responses were interpolated to 1 s intervals, time aligned and averaged. The data following phase I, estimated to be 15 s for all participants, were fit using a single exponential model including a delay term within a fitting window that was previously identified to exclude the slow component. The $\dot{V}O_2$ slow component was computed as the difference between the amplitude of the primary component and the end-exercise $\dot{V}O_2$ and was expressed as the percent contribution to the total change in $\dot{V}O_2$. Paired samples t tests were used to investigate differences over time with the alpha value adjusted using the Bonferroni procedure. Statistical significance was set at the $P < 0.01$ level. Omega squared (ω^2) effect size statistics were used to investigate the magnitude of any differences between test occasions.

No significant differences were found for $\dot{V}O_2$ peak between test occasions ($P=0.642$). The phase II time constant significantly lengthened over time ($P=0.003$, effect size $\omega^2=0.44$). Although not statistically significant, the absolute amplitude of the $\dot{V}O_2$ slow component increased by 44% over time ($P=0.018$, effect size $\omega^2=0.27$). The end-exercise gain was also significantly greater on test occasion 2 ($P=0.002$, effect size $\omega^2=0.46$). Over a 2-yr period, the phase II kinetics lengthened and the $\dot{V}O_2$ slow component amplitude increased, causing an elevation in the end-exercise gain. A slower phase II response and larger $\dot{V}O_2$ slow component has significant implications on exercise tolerance during heavy-intensity exercise. Future experimental work designed to manipulate exercise regimen and alter muscle recruitment patterns is important to further understand the mechanistic basis for maturational effects on $\dot{V}O_2$ kinetics during heavy-intensity exercise.

HPHP4-12

Strenuous exercise-induced increase in salivary transferrin: A marker of salivary blood contamination

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Many studies in the Sport and Exercise Sciences require the assessment of analytes in saliva. The screening of saliva samples for the presence of blood (blood contamination) is uncommon. However, it has been demonstrated that blood contamination of saliva may invalidate measures of salivary hormones such as testosterone, for example (Kivlighan, Granger, & Schwartz, 2005: *Hormones and Behaviour*, 47, 367–370). Since many studies in Sport and Exercise Sciences are concerned with the effects of exercise on such measures, the aim of the present study was to examine the effects of exercise on salivary blood contamination.

With University Ethics committee approval, 22 participants (17 males and 5 females) aged between 18–40 years (Age mean 28.2, $s=8.0$ years) volunteered for this study. Resting saliva samples were collected (timed, unstimulated passive dribble) in order to determine the incidence of salivary blood contamination. Seven of the male participants (Age mean 25.0, $s=8.4$ years) also undertook a graded exercise test to volitional fatigue on a cycle ergometer. A second saliva sample was collected approximately 5 min after completion of the exercise test. Salivary blood contamination was assessed by the duplicate measurement of salivary transferrin concentration using a commercially available enzyme linked immunosorbant assay (ELISA) kit (Salimetrics, State College, PA. USA). Blood contamination was assumed if salivary transferrin concentration exceeded 1.0 mg/dl.

Blood contamination was detected in the resting saliva samples from ~18% of the participants (4 out of 22). Blood contamination was apparent in ~14% of the exercising participants (one of seven) at rest. There was a significant increase (paired t test, $P=0.015$) in the mean concentration of salivary transferrin following exercise (mean concentration of 0.38, $s=0.44$ mg/dl before exercise compared with 1.39, $s=1.67$ mg/dl after exercise). This response was unaltered ($P=0.015$) when transferrin concentration was adjusted for loss of salivary water (normalisation using saliva osmolality). Furthermore, the post-exercise incidence of blood contamination was ~43% (three out of seven) in both the adjusted and unadjusted data. This suggests that strenuous exercise may result in an increase in blood

contamination of saliva in some individuals. Therefore, screening saliva samples for blood contamination may be particularly useful to ensure validity of salivary measures in exercise studies.

HPHP4-13

Reliability and validity of field-based measures of leg stiffness and reactive strength in youths

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Leg stiffness and reactive strength (RS) are measures of stretch-shortening cycle function that can be calculated from simple field-based measures of contact time and flight time during rebound jumping. Such measures are important for monitoring speed and power development in youths. Therefore, the study aimed to assess the reliability and validity of field-based measures of leg stiffness and RS in paediatric populations.

Following university ethical approval, 21 participants (mean age 13.5, $s=0.51$ years) completed a reliability study involving three test sessions completed on separate days. Three trials of 5_{max}-rebound jumps (5RJ) (best effort recorded), and single trials of sub-maximal hopping at frequencies of 2.0 Hz and 2.5 Hz, were performed in each session, using a mobile contact mat (Smartspeed, Fusion Sport, Australia). Leg stiffness was calculated from each test, whilst RS was also calculated during the 5RJ. An additional validity study was completed using 20 participants (mean age 16.5, $s=0.51$ years). Participants performed single trials of the 5RJ and sub-maximal hopping at both frequencies. Measures of leg stiffness using contact time were validated against those obtained from force plate data (Kistler, type 9287BA, Switzerland).

No mean biases across repeated trials for any variable were found. Mean coefficients of variation [CV] for leg stiffness across all three trials of 2.0 Hz hopping, 2.5 Hz hopping and the 5RJ were 13.9%, 10.2% and 21.4%, respectively. The mean CV for RS was 14.0%.

Validity of leg stiffness for sub-maximal hopping revealed strong correlation coefficients and low typical error of estimates (TEE) between methods [2.0 Hz: $r=0.98$, TEE=6.5%; 2.5 Hz: $r=0.95$, TEE=7.5%]. Conversely, the 5RJ produced poor correlations ($r=0.59$) and high TEE (41.9%).

The precision of both leg stiffness and RS measures has implications for monitoring

performance and planning future experimental studies with youth populations. Field-based methods of calculating leg stiffness in youths are deemed valid for sub-maximal hopping, but not for maximal rebound jumps. Owing to the time-saving benefits and ease of administration, the mobile contact mat is viewed as an effective tool to measure SSC performance.

HPHP4-14

Acute exercise effects on cardiovascular risk factors in obese patients with impaired glucose tolerance

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The relationship between obesity and the development of non-insulin dependent diabetes mellitus (NIDDM) is well established. It is generally accepted that individuals proceed through impaired glucose tolerance (IGT) before progressing to NIDDM, establishing IGT as a pre-diabetic state. Physical activity is commonly prescribed as a therapeutic modality in the treatment of NIDDM, with the aim of reducing the severity of the co-morbidities associated with the disease. Conversely, evidence is sparse regarding the potential benefits which physical activity may confer in the early manifestations of the disease. It has been estimated that individuals at high risk of NIDDM (such as those with IGT), may have up to a 50% risk reduction by performing regular exercise from Kriska and Bennett (1992: *Diabetes Metabolic Reviews*, 8, 335–372). The purpose of this study was to investigate the effects of an acute bout of moderate intensity exercise in obese subjects with IGT.

Following ethical approval, twelve obese participants (Male, $n = 7$, Female $n = 5$, Age mean 48, $s = 9$ years; stature mean 1.68, $s = 0.07$ m; body mass mean 90.7, $s = 16.8$ kg) diagnosed with IGT were recruited via a local Diabetic Clinic.

Following a preliminary health screen and 12 h fast, participants completed a 30 min acute bout of moderate intensity exercise equivalent to 60% age predicted maximum heart rate (HR_{max}). Venous blood samples were obtained from a forearm vein prior to biochemical assessment. Following correction for plasma volume shifts according to the equations of Dill and Costill (1974: *Journal of Applied Physiology*, 37, 247–248), pre- and post-exercise data were analysed using a paired samples t tests.

Blood glucose concentration (mmol/L) significantly decreased following exercise ($P < 0.05$). While there were no changes found in the plasma concentration of triacylglycerol, total cholesterol, high density lipoprotein and low density lipoprotein cholesterol or in glycated haemoglobin ($P > 0.05$).

This exercise induced effect on increased glucose uptake into muscle cells and is thought to have occurred independent of insulin action. It may be caused by increased GLUT 4 protein activation and translocation to the cell membrane. This in turn may elicit improved metabolic control and therefore help reduce the increased risk of progression to NIDDM.

HPHP4-15

An interrelationship between lactate and carbohydrate utilisation explains the cross-over point inter-individual variability

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The cross-over point (COP) is defined as the power output where energy from CHO derived fuels predominates over energy from lipids, and shown to be sensitive to fitness status, reflecting the biochemical adaptations that affect CHO and fat oxidation at COP (Brooks & Mercier, 1994: *Journal of Applied Physiology*, 76, 2253–2261). High inter-individual differences have been reported at several intensities where CHO and fat interact, including those at COP (Venables *et al.*, 2005: *Journal of Applied Physiology*, 98, 160–167). Various BLC levels have been suggested to explain these inter-individual differences including thresholds at 2 and 4 mmol \cdot L⁻¹ (Bircher *et al.*, 2005: *European Journal of Clinical Investigation*, 35, 491–498; Billat *et al.*, 2004: *European Journal of Applied Physiology*, 447, 875–883). Based on the idea that lactate may be used to indicate pyruvate availability, an interrelationship between BLC and relative rates of pyruvate combustion (RPY) has been proposed (Beneke *et al.*, 2005: *ECSS 10th Annual Congress*, 93). The latter suggests that RPY changes may be reflected by individual BLC levels, as indicated by a constant (kel) describing RPY as a function of BLC. The present study investigates whether kel serves as an independent factor to explain COP variance.

Twenty one healthy males (Age mean 26.3, $s = 6.0$ years, Height 179.4, $s = 8.1$ cm, Body mass (BM) 74.9, $s = 12.5$ kg) completed an incremental cycling test. The workload was initiated with 1 W \cdot kg⁻¹ BM and increased by 0.5 W \cdot kg⁻¹ BM every 2 min stage. Capillary blood samples were drawn at rest and at the

end of each stage. Respiratory $\dot{V}O_2$ and $\dot{V}CO_2$ were measured and analysed for estimating CHO and fat oxidation using indirect calorimetry. RPY was calculated as a percentage of full pyruvate combustion (when $\dot{V}O_2$ equals $\dot{V}CO_2$). kel was approximated based on the following interrelationship between RPY and BLC: $RPY = 100/(1 + kel/BLC^2)$. BLC thresholds at 2 (BLC2) and 4 (BLC4) $mmol \cdot L^{-1}$ were determined based on corresponding intensities relative to peak power. COP was calculated as the intensity where $> 50\%$ of energy is derived from CHO.

COP was 161.35, $s = 48.02$ W corresponding to 42.14, $s = 10.07\%$ of peak power and 49.46, $s = 10.53\%$ $\dot{V}O_{2peak}$ and BLC levels of 1.5, $s = 0.4$ $mmol \cdot L^{-1}$. Estimates of kel were 1.75, $s = 1.10$ ($mmol \cdot L^{-1}$)². kel explained 30.6% of the variance in COP ($P < 0.01$). This was improved to 76.2% when adding BLC2 as a predictor ($P < 0.001$), whereas BLC4, peak power, and $\dot{V}O_{2peak}$ were not predictors.

This suggests that kel may serve as a useful indicator for COP, and may explain inter-individual variability at that point.

HPHP4-17

Are haemorheological responses to resistance exercise intensity related?

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Many studies have shown that all accepted cardiovascular risk factors are associated with abnormalities in the flow properties of blood. Considering the importance of selecting an appropriate exercise and training intensity, surprisingly little is known about blood rheological alterations associated with varying intensity of resistance exercise.

The University's ethics committee initially approved the experimental procedures and study protocols, and a written consent form was obtained. Thirteen healthy male participants (Age mean 26.4, $s = 7$ years) randomly completed three sets of 10 repetitions at 40% of one repetition maximum (1RM), three sets of seven repetitions at 60% of 1RM and three sets of five repetitions at 80% of 1RM. Participants performed six exercises including upper and lower body parts. Exercise volume (sets \times reps \times weight) for the three different intensities was kept constant. Venous blood samples (7 mL) were obtained before and immediately after each exercise trial and analysed for haematocrit

(Hct), haemoglobin (Hb), Plasma viscosity, fibrinogen, total protein, and albumin concentration.

Although plasma volume changes in response to all exercise intensities were not significantly different, the magnitude of plasma volume reduction following 80% of 1RM exercise trial (9.7%) was greater than 40% (8.5%) and 60% (8.7%) trials. Plasma viscosity increased significantly from mean 1.55, $s = 0.07$ to mean 1.64, $s = 0.05$ mPas, from mean 1.55, $s = 0.05$ to mean 1.63, $s = 0.05$ mPas, and from mean 1.56, $s = 0.06$ to mean 1.63, $s = 0.08$ mPas following 40%, 60%, and 80% trials, respectively. These responses were not related to the intensity of exercise. Plasma fibrinogen concentration elevated significantly in response to all exercise intensities with no significant difference among the three trials. Data analysis indicated significant main effect of exercise for serum total protein ($F_{1,12} = 21.6$, $P < 0.05$) and albumin concentration ($F_{1,12} = 10.9$, $P < 0.05$). However, these responses were not related to the intensity of exercise.

In contrast to previous studies that were suffering from the lack of controlling the resistance exercise volume, in the present study the volume of exercise was kept constant for all exercise trials. Therefore, it might be suggested that changes in haemorheological variables in response to resistance exercise occur irrespective of exercise intensity when they are equated for volume.

HPHP4-20

Relationship between extra-school sport involvements with participation motivation in physical education programme

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According to sport adherence theoretical model, the participation in the exercise programmes depends on many factors (Biddle & Mutrie, 2005: *Psychology of physical activity*, Routledge, Taylor & Francis Group, p. 45). Personal characteristics such as motivation are important determinant. Participation motivation is important elements in youth sport especially, for school physical education programme. The great deal of scientific studies have shown that the adolescents reasons for participation in sport and physical activity are different (Zahariadis & Biddle, 2000: *The Online Journal of Sport Psychology* 2(1). Retrieved from http://www.athleticinsight.com/vol2/ISSI/English_Children.htm; Yan & McCullagh, 2004: *Journal of Sport Behavior*, 27(4), 378–390; Ae, Amagasaki, & Kakemizu, 1999: *Motives to remain in competitive college sports*, 5th IOC World Congress

on Sport Sciences, Sydney, Australia,)), but their importance for future sport involvement is more vital. The aim of the present investigation was to study the association between extra-school sport involvements with personal factor such participation motivation in adolescent students.

With institutional ethical approval 1180 male and female adolescent students (11–19 years) who selected through cluster random sampling method from Tehran state, completed Participation Motivation Questionnaire (Gill, 1999: *Psychological dynamics of sport and exercise*, (2nd edn.). Champaign: Human Kinetics Publisher, p. 89), and responded to a question about their involvement in extra-school sport activities. The motivation questionnaire was consisted of 30 items and each item is rated on a 5-point Likert-type scale ranging from 1 (completely unimportant) to 5 (completely important). For the sport involvement, the participants responded to this dichotomous question (yes/no) “do you play any sport activities outside of your school physical education programme” and classified into adherers and non-adherers groups. The exploratory and confirmatory factor analyses have shown that the motivation of adolescent students for participation in school physical education was multidimensional and includes status, skill learning, energy release, compete, team, significant others and friends. The step wise discriminate analysis indicated that the participation motivation in school’s physical education is significant predictor ($R_c = 0.18$, Wilks Lambda $_{4,1147} = 0.96$, $F_{4,1144} = 9.42$, $P < 0.01$) for extra-school sport activities. The standardised canonical coefficients results have shown that from seven motivational factors, skill learning ($r = 0.94$) and compete ($r = 0.39$) had positive correlations and energy release ($r = -0.55$) and status ($r = -0.50$) had negative correlations with extra-school sport involvement, but other reasons were not significant predictors. The current findings have supported the role of personal motivation in youth sport adherence particularly if it concerns with self-referenced or intrinsic motivation.

The results emphasise the important role of physical education teachers in promoting healthy lifestyle for students through planning the organised programmes in physical education class to meet the students’ needs, so they can transfer these motives to their next life period.

HPSP4-23

The development of an observational assessment tool examining environmental support within physical activity consultations

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Grounded in Self Determination Theory (Deci & Ryan, 1985: *Intrinsic motivation and self determination in human behaviour*. New York: Plenum), the aim of this study was to develop and test the inter-rater reliability of an observational measure of environmental support reflected in the interpersonal style of health and fitness advisors during physical activity consultations. The instrument taps four dimensions of the interpersonal style of the advisor: namely, Autonomy (facilitation of the client’s endorsement of his/her desire and choices for behavioural change), Involvement (provision of time, attention and dedication), Structure (provision of clear guidelines and expectations) and, a negatively scored dimension labelled Control (the enforcement of the advisor’s personal agendas with the client).

With institutional ethics approval secured, three trained raters observed filmed physical activity consultations and independently rated the targeted dimensions of the consultation environment. The observational instrument comprised 23 items (capturing the four dimensions) which were rated on a 7-point Likert-type scale (1 = not at all true and 7 = very true). In a pilot study, seven consultations were rated and 14 consultations, to date, were subsequently rated during an ongoing main trial.

The overall intra-class correlation coefficient (ICC) was calculated for the observational instrument based on the pilot study (ICC = 0.68), with the ICCs for the four behavioural dimensions ranging from 0.53 to 0.72. Using the stringent levels recommended by Shrout (1998: *Statistical Methods in Medical Research*, 7, 301–317), the overall ICC suggested a moderate level of inter-rater reliability. Based on the pilot work, some revisions were made to the instrument. Determination of the overall inter-rater reliability of the revised instrument revealed an overall coefficient of 0.79. Ratings for each subscale revealed a range of inter-rater reliabilities from fair (Involvement ICC = 0.49) to moderate (Structure ICC = 0.80).

Our data provide support for the development of a non-self report, and thus more objective, assessment of environmental support provided by advisors during a physical activity consultation. This instrument may be employed to assess the fidelity of

Table I. The intraclass correlation coefficients for the pilot and main trial.

Scale	Pilot ($n = 7$)	Live ($n = 14$)
Autonomy	0.53	0.79
Involvement	0.72	0.49
Structure	0.61	0.80
Control	0.61	0.66
Overall	0.68	0.79

interventions centred on the promotion of environmental support in exercise consultations.

HPSP4-25

The effects of self-monitoring and self-monitoring plus extra staff attention on self-esteem, stage of change and self efficacy

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The most commonly applied stage model in the exercise domain is the Transtheoretical Model (TTM; Prochaska & DiClemente, 1983: *Journal of Consulting and Clinical Psychology*, 51, 390–395). For over a decade, studies across a wide range of populations and settings have demonstrated the existence of a significant relationship between exercise behaviour and the TTM (Fallon *et al.*, 2005: *Psychology of Sport and Exercise*, 7, 1–13). The aim of the current study was to examine the effects that different exercise leaderships had on self-esteem, and the stage of change and self-efficacy constructs of the TTM.

Following ethical approval, and a pilot study, 90 participants took part in this study ($N=90$). Participants were divided into four groups, a control group ($n=30$), individuals who ($n=30$) and two groups of individuals that took part in prescribed exercise, GP exercise referrals ($n=17$) and self-monitoring with extra staff attention ($n=13$). The study lasted for 8 weeks. Participants' movement through the stages of change, their self-efficacy and self-esteem levels were measured at the end of every week. Stage of exercise behaviour change was assessed using the Stage of Change Instrument (SCI; Marcus & Simkin, 1993). Self-efficacy for physical activity was measured using the exercise self-efficacy scale (McAuley, 1993) and self-esteem was measured by a 10-item index adapted from Rosenberg's (1965) Self-Esteem Scale.

Univariate analysis of variance (ANOVAs) were used to conclude that self-monitoring with extra staff attention was the only exercise type to have a significant effect (0.04) on progression through the stages of change. This study also concluded that self-monitoring with extra staff attention was the only exercise type to have a significant effect (0.03) on self-efficacy. None of the exercise types had a significant effect on self-esteem although positive progression was visible throughout all four groups.

It can therefore be concluded from this study that prescribed exercise in the form of personal training with extra staff attention should be more widely used within the physical activity environment as it has the

most significant effect in relation to progression through the stages of change and also had the most significant effect on self-efficacy. A longitudinal based study should also be conducted to investigate the effects of different exercise modulates on self-esteem as a positive if not significant change was evident.

HPSP4-26

Leisure-time physical activity and sedentary behaviours in young Chinese people

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Data show that there is an increase in obesity and overweight in older children and adolescents in China (Wang *et al.*, 2002: *American Journal of Clinical Nutrition*, 75, 971–977), and that sedentary behavioural patterns may be partially responsible. However, limited data are available concerning physical activity and sedentary behaviours undertaken by young people in China. The aim of this study, therefore, was to investigate the key leisure-time sedentary behaviours in young people in North-East China alongside their physical activity behaviours. Comparisons are drawn with UK data.

School students ($n=112$; male $n=54$, female $n=58$), aged 15–18 years (mean 15.9, $s=0.6$) volunteered to participate. Participants completed an ecological momentary assessment, "free-time", diary (Dunton *et al.*, 2005: *American Journal of Preventive Medicine*, 29, 281–287) on a typical school day that was randomly assigned. Seventeen key behaviours were analysed using SPSS V15.0.

Results showed that Chinese youth report 671.7 min of sedentary behaviours (classified as watching television, doing homework, motorised transport, sitting and talking, shopping/hanging out in town, listening to music, using the telephone, using the computer, reading, sitting doing nothing, playing computer/video games and cognitive hobbies) and 152.0 minutes of physical activity (classified as active transport, behavioural hobbies, sports and exercise, doing chores and unstructured play). In line with previous studies (Ming *et al.*, 2007: *Journal of Adolescent Health*, 41, 99–101) doing homework occupied the most leisure time of Chinese students (328.6 min), followed by watching television (146.3 min), unstructured play (74.3), and sitting and talking (73.1 min). Motorised and active forms of transport occupied about the same time of

weekday activities (56.6 and 52.8 min respectively). Surprisingly, less time consuming activities were using the telephone (2.7 min), using a computer (3.1 min) and sports and exercise (9.2 min) in China compared with data from the United Kingdom (13.1, 10.3 and 18.6 min respectively), while more time was spent on reading in China (30.0 min) than in the UK (10.2 min; Gorely *et al.*, 2007: *International Journal of Pediatric Obesity*, 2(4), 227–234).

Results highlight the cultural differences in sedentary behaviours and physical activity between Chinese and British youth. In the UK, young people appear to spend more time on electronic communication (computer, phone) than in China, but less on homework and reading. Future research should focus on the time trends of both sedentary and active behaviours, and the potential consequences on young people's health in larger samples.

HPHP4-27

Perceived motivational climate and dropout in young athletes

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Motivational factors have been used in numerous researches that have tried to explain the persistence or dropout of a sport activity in their participants (Ntoumanis, 2005; *Journal of Educational Psychology*, 97, 444–453). Studies have provided a strong indication of the important role that parents, coaches and peers motivational climates play in the abandonment of the sporting practice

(Reinboth & Duda, 2007: *Psychology of Sport and Exercise*, 7, 269–286).

The aim of this work is to verify how the motivational climate perceived by parents, coach and peers can support the persistence or dropout intentions of sport activity.

Participants were 1007 athletes with ages ranging from 13 and 16 years old (Age mean 14.2 years, $s=1.5$) who were analyzed their motivational climate and behavioural intentions to continue the sporting practice. They completed the Perception Motivational Climate in Sport Questionnaire-2 (Newton *et al.*, 2000: *Journal of Sports Sciences*, 18, 1–16), Parental Involvement in Sport Questionnaire (Lee & Mclean, 1997: *European Journal of Physical Education*, 2, 167–177) and Peer Motivational Climate in Youth Sport Questionnaire (Ntoumanis & Vazou, 2005: *Journal of Sport & Exercise Psychology*, 27, 432–455). Participants also completed a 7-item measure of behavioral intentions about how they felt to continue or dropout in their sport in the following season.

Results showed a strong relationship between parents, coaches and peers perceptions of a mastery climate with the persistence, whereas performance climates was associated with dropout.

Table II showed the weight of regression of the variables introduced in structural equation modeling. As can be seen, mastery climate positively predicted the persistence whereas performance climate predicted the dropout. Model estimation yielded a satisfactory fit ($\chi^2=80.307$; $p=.05$; $\chi^2/df=4.461$; $CFI=.95$; $GFI=.98$; $RMSEA=.050$; $SRMR=.051$).

In this study, parents and coaches were more influential in adolescents' adoption of persistence or dropout behaviours than peers.

Table I. Correlations among the motivational climate factors and the persistence or dropout intentions of sport activity.

	Mastery parents	Performance parents	Mastery peers	Performance peers	Mastery coach	Performance coach
Persistence	.317**	-.030	.325**	.021	.429**	-.126
Dropout	-.017	.338**	-.045	.212**	-.124	.391**

** $p < .001$.

Table II. Estimated parameters for the model.

	β	S.E.	C.R.	P
Coach mastery climate \rightarrow persistence	.425	.03	11.65	.000
Peers mastery climate \rightarrow persistence	.221	.03	6.98	.000
Parents mastery climate \rightarrow persistence	.243	.02	7.44	.000
Coach performance climate \rightarrow dropout	.422	.04	11.62	.000
Peers performance climate \rightarrow dropout	.031	.03	1.13	.27
Parents performance climate \rightarrow dropout	.295	.03	8.15	.000

HPHP4-28

The 2 × 2 achievement goal framework and sport commitment

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In the sport domain, several researchers have proposed a 2 × 2 achievement goal framework (Morris & Kavussanu, 2008: *Journal of Sports Sciences*, 26, 465–476). Thus, they suggested that performance approach goals may have adaptive effects whereas performance avoidance goals are showed to have detrimental effects on motivational outcomes.

In this way, commitment is a psychological construct commonly used in sport to refer to the motivation to continue practicing a sport (Weiss *et al.*, 2001: *Pediatric Exercise Science*, 13, 131–144) and includes six dimensions: Sport Commitment, Sport Enjoyment, Personal Investments, Social Constraints, Involvement Opportunities and Involvement Alternatives.

The aim of this work was to examine the 2 × 2 achievement goal framework and their relationships regarding sport commitment in young athletes.

Participants were 703 athletes with ages ranging from 12 to 16 years old (Age mean 14.3, $s = 1.6$ years). They completed the 2 × 2 Achievement Goals Questionnaire for Sport (Conroy *et al.*, 2003: *Journal of Sport & Exercise Psychology*, 25, 456–476) and the Sport Commitment Questionnaire (Scanlan,

et al., 1993: *Journal of Sport & Exercise Psychology*, 15, 16–38). Items were rated on a 5-point Likert-type scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*).

Results showed similar relationships between performance goals and sport commitment. Mastery approach goals had a very strong relationship with performance approach goals or perceptions.

To examine the contribution of achievement goals to commitment factors in young participants, a multiple linear regression analysis was conducted.

Results revealed that mastery approach goal was the most suitable orientation for the sport commitment, whereas performance avoidance is positively associated and predicted the negative factors of the sport commitment.

HPHP4-29

Relationships among muscle dysmorphia and body image-related quality of life and coping strategies

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Muscle dysmorphia refers to the preoccupation individuals may have regarding their levels of muscularity, and signs may include excessive weight-lifting, excessive attention to diet, anxiety,

Table I. Correlations among the 2 × 2 achievement goals and the sport commitment factors.

	Commitment	Enjoyment	Involvement alternatives	Social constraints	Involvement opportunities	Personal investments
Mastery approach	.360**	.390**	-.091*	.063	.369**	.380**
Mastery avoidance	.098*	.054	.097*	.099**	.116**	.069
Performance approach	.059	.025	.238**	.260**	.072	-.005
Performance avoidance	.073	-.032	.305**	.341**	.059	-.060

** $p < 0.01$. * $p < 0.05$.

Table II. Standardized regression coefficients for the sport commitment factors.

Independent variables	Dependent variables					
	Sport commitment	Sport enjoyment	Involvement alternatives	Social constraints	Involvement opportunities	Personal investments
Mastery approach	.461**	.405**	-.213**	-.035	.296**	.314**
Mastery avoidance	.031	.031	.028	.011	.053	.023
Performance approach	-.007	-.011	.021	.215**	.034	-.027
Performance avoidance	-.017	-.197**	.324**	.410**	.041	-.054
Total R^2	.231	.304	.242	.321	.212	.222

social impairment, and steroid use (Choi *et al.*, 2002: *British Journal of Sports Medicine*, 36, 375–377). Currently, investigators have conducted only a small number of studies and most research has been atheoretical. The purpose of this study was to examine relationships muscle dysmorphia has with body image-related quality of life and coping strategies, and was underpinned by Cash's (2002: In *Body image*, edited by T. Cash & T. Pruzinsky. London: Guilford Press) cognitive-behavioural body image model.

After receiving ethical clearance, 412 undergraduate students (117 females, 292 males and 3 undeclared; Age mean 20.3, $s = 2.9$, years) provided written informed consent and completed the Body Image Quality of Life Inventory (BIQOLI; measuring the influence body image has on quality of life), the Body Image Coping Strategies Inventory (measuring the avoidance of social situations, appearance fixing, and positive rational acceptance) and the Muscle Appearance Satisfaction Scale (MASS; measuring bodybuilding dependence, muscle checking, willingness to train when injured, substance use, and muscle satisfaction). Correlations greater than 0.128 were considered significant ($P < 0.01$).

BIQOLI and muscle satisfaction scores were negatively correlated ($r = -0.26$). Appearance fixing was correlated with bodybuilding dependence ($r = 0.32$), muscle checking ($r = 0.41$), substance use ($r = 0.23$), willingness to train when injured ($r = 0.31$), muscle satisfaction ($r = 0.29$) and the MASS total score ($r = 0.42$). Avoidance was correlated with bodybuilding dependence ($r = 0.15$), muscle checking ($r = 0.19$), willingness to train when injured ($r = 0.18$), muscle satisfaction ($r = 0.18$), and the MASS total score ($r = 0.21$). Rational acceptance was correlated with bodybuilding dependence ($r = 0.21$), muscle checking ($r = 0.21$), willingness to train when injured ($r = 0.26$), and the MASS total score ($r = 0.23$).

These results indicate that individuals reporting signs of muscle dysmorphia may also engage in body image-related coping strategies and believe their body image influences their quality of life. Findings provide sport scientists with insights into the types of behaviours people experiencing muscle dysmorphia may exhibit and their quality of life-related perceptions.

HPSP4-31

An investigation into transformational leadership and self-determination theory

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Transformational leadership is proposed to activate higher order needs, encourage followers to transcend their own self-interest for the greater good, and increase the value of tasks (Bass, 1985: *Leadership and performance beyond expectations*. New York: The Free Press). Self-determination theory (Deci & Ryan, 1985. *Intrinsic motivation and self-determination in human behaviour*. New York: Plenum Press) posits that internalisation of behavioural regulation will be facilitated by satisfying needs for autonomy, competence, and relatedness. The current study was set in a military context and examined the impact of transformational leadership on the behavioural regulation of the core values of the British armed forces: selfless-commitment; courage; discipline; integrity; loyalty; and respect for others.

UK based infantry soldiers took part in this study (Age mean 24.8, $s = 2.9$ years). The soldiers were on an 8 week promotional training course that was designed to train them to be first level leaders in an operational context (section corporals). A motivational regulation scale was developed specifically for this study to assess the extent to which behavioural regulation was external, introjected, and integrated. Hardy *et al.*'s (*in press*, *Leadership Quarterly*) leadership scale was used to measure follower perceptions of their direct leaders' behaviours. Motivation was assessed at the beginning and end of training. Follower perceptions of their leaders' behaviours were assessed in week 4 of training.

Partial correlations controlling for week 1 behavioural regulation revealed that inspirational motivation, appropriate role modelling, fostering acceptance of group goals, and intellectual stimulation were significantly correlated with integrated regulation, whilst none of the transformational leader behaviours were significantly correlated with external regulation.

Regression analyses (week 1 behavioural regulation entered in block 1, all the leader behaviours entered stepwise in block 2) for each of the core values revealed that appropriate role modelling and

Table I. Partial correlations between transformational leader behaviours and regulation of core values at week 8 controlling for week 1 regulation of values.

	External	Introjected	Integrated
Inspirational motivation	0.15	0.16	0.31**
High performance expect.	0.21	0.19	0.17
Appropriate role model	0.19	0.20	0.30**
Fosters group goals	0.21	0.19	0.32**
Intellectual stimulation	0.17	0.25*	0.38**
Individual consideration	0.16	0.04	0.18

* $P < 0.05$; ** $P < 0.01$.

intellectual stimulation were the most important behaviours in predicting integrated regulation.

HPSP4-32

Body self-discrepancies and social physique anxiety: The role of sex and the feared self

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The large body of research on social physique anxiety has demonstrated a positive relationship with eating disorder symptomatology and related criterion variables including negative eating and exercise behaviours, body dissatisfaction, depression, and ideal body self-discrepancies. However, research examining the body self-discrepancy-social physique anxiety relationship has neglected to examine ought or feared selves. A recent study by Woodman and Hemmings (in press, *Self and identity*) demonstrated the importance of considering these selves and specifically, interactions between approach and avoidance selves. Thus, the present study examined ideal, ought and feared body fat and muscularity self-discrepancies as predictors of social physique anxiety; interactions between approach and avoidance selves; and further, sex as a moderator of approach \times avoidance self interactions.

Following institutional ethical approval, 200 participants (100 Men, 100 Women, $M_{\text{age}} = 28.34$ years, $SD = 11.17$) completed actual, ideal, ought and feared body self-discrepancy visual analogue scales, the Social Physique Anxiety Scale (Hart *et al.*, 1989: *Journal of Sport & Exercise Psychology*, 11, 94–104) and the Beck Depression Inventory-II (Beck *et al.*, 1996: *Manual for the Beck Depression inventory-II*. San Antonio: Psychological Corporation).

After controlling for ideal body fat discrepancies and depression, moderated hierarchical regression analyses revealed a three-way, ought \times feared \times sex interaction ($R^2_{\text{cha}} = 0.01$, $P < 0.01$; $\beta = 0.15$, $P < 0.01$) indicating that the relationship between ought body fat discrepancies and social physique anxiety was moderated by proximity to the feared fat self for women ($R^2_{\text{cha}} = 0.06$, $P < 0.01$; $\beta = 0.30$, $P < 0.01$) but not for men ($R^2_{\text{cha}} = 0.001$; $\beta = -0.03$ ns). Simple slopes analysis indicated that ought fat discrepancies were a stronger predictor of social physique anxiety when women were far from their feared self ($\beta = 0.88$, $P < 0.001$) than when they were close to their feared self ($\beta = 0.32$, $P < 0.001$). No significant muscularity discrepancy-affect relationships were revealed.

The results provide strong support for the feared self as a moderator of approach discrepancy-social

physique anxiety relationships and for sex as a moderator of the interaction between approach and avoidance selves. Practitioners interested in assisting women who experience social physique anxiety need to consider the individuals' proximity to their feared self, before considering where they are in relation to their approach selves.

HPSP4-33

A preliminary investigation to identify key barriers to physical activity in the Black and racial minority population in Liverpool

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Despite the clear health benefits that can be attained through adopting a more active lifestyle (DOH, 2004: *At least five times a week: Evidence on the impact of physical activity and its relationship to health*, report by the Chief Medical Officer), the BRM population show low levels of physical activity (PA) (Kruger *et al.*, 2007: *Mortality and Morbidity Weekly Reports*, 56(13); K. Sporston & R. Primatestra (eds.) 2003: *Health survey for England*. London: HMSO). Little is known about the barriers to PA among the BRM population. Understanding barriers to PA may also help to guide the development, implementation, and evaluation of interventions. Therefore the purpose of this research was to identify the barriers to PA in BRM groups in Liverpool.

A questionnaire was developed in partnership with Kensington Women's Health Information Service Centre that focused on BRM women's PA patterns and socio-demographic, social and environmental factors and policies. Participants were 213 women from 15 different BRM groups living in deprived areas of Liverpool. Questions were asked in the form of a semi-structured interview. The researcher filled the questionnaire along with the participants. Interviews took place in a variety of settings.

Perceived constraints and barriers around physical activity were grouped according to intrapersonal (17%), interpersonal (52%), social (2%) and environmental (19%) factors. Specific reasons were lack of time due to family commitment and childcare or work commitments, lack of motivation and attitude towards physical activity, not having a friend or a company to do physical activity with and lack of information about the type and place of the facilities available and also lack of childcare facilities. The survey approach may have constrained findings and prevented access to more detailed contextual data.

The key barriers to PA are mainly interpersonal and are related to time and a lack of information and resources. There were no significant differences in barriers to PA between BRM groups. Findings will be used to inform qualitative investigations into the opinions, attitudes, and reasons for PA behaviour and to understand how to overcome the constraints to a engaging in a more physically active lifestyle in BRM groups.

HOTP4-36

The reliability of a new soccer skills test

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Passing and shooting accuracy are thought to contribute to success in soccer. Previous tests that aim to measure these skills have provided criterion-based outcomes. Therefore, we aimed to examine the reliability of a new test that quantitatively assesses the accuracy of passing and shooting.

Following institutional ethical approval, thirteen familiarised academy soccer players (age mean 18.77, $s = 4.87$ years, height mean 1.74, $s = 0.05$ m, mass mean 69.62, $s = 11.70$ kg) completed a test incorporating passing and shooting on two occasions. The test included seven bouts of passing, aiming at short (4.2 m) and long (7.9 m) targets, and two bouts of shooting (15.0 m) towards targets in each corner of the goal. The players were required to kick a ball moving at 2.3 m/s towards one of four passing or shooting targets. Lights were illuminated on each target in a randomised sequence, enabling target identification 0.4 s after ball release; thereby requiring visual search and decision making during both skills. Accuracy, represented by deviation from the target, was determined using video analysis (VICON Motus 9.2, VICON Motion Systems, USA).

For passing, a repeated measures ANOVA revealed non-significant main effects of trial (mean 0.34, $s = 0.11$ m *versus* mean 0.33, $s = 0.10$; $P = 0.408$, effect size *Partial* $\eta^2 = 0.058$), bout ($P = 0.335$, effect size *Partial-eta*² = 0.088) and distance of target ($P = 0.075$, effect size *Partial* $\eta^2 = 0.172$). Similarly, trial ($P = 0.998$, effect size *Partial* $\eta^2 = 0.000$) and bout ($P = 0.529$, effect size *Partial* $\eta^2 = 0.037$) did not influence shooting accuracy. However, shots to upper targets were less accurate (mean 1.36, $s = 0.54$ m *versus* mean 0.85, $s = 0.36$ m; $P = 0.000$, effect size *Partial* $\eta^2 = 0.697$) and had higher miss rates (mean 42.2, $s = 23.6\%$ *versus* mean 21.9, $s = 19.7\%$, $P = 0.002$, effect size *Partial* $\eta^2 = 0.572$) when

compared with those aimed at lower targets, suggesting a difference in shot difficulty.

This is the first test to provide quantification of ball deviation from a target during soccer passing and shooting tasks that require visual search and decision making. The lack of differences between trials indicates that the test provides a reliable measure of passing and shooting performance in familiarised soccer players.

HOTP4-37

Psychological skills training and subjective assessment of soccer-midfielder performance

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Although evidence suggests psychological skills benefit sports performance, many studies measure performance outcomes alone. Further, it is only of late that research has shown how such skills enhance specific roles within a sport (e.g. Thelwell *et al.*, 2005: *Journal of Applied Sport Psychology*, 18, 254–270). Despite the measurement of specific roles, questions regarding performance measurement exist, where there is a tendency to employ objective (that is often influenced by uncontrollable factors) rather than subjective scoring. For example, a soccer midfielder who identifies a correct pass that is not anticipated by the recipient would receive a negative mark, despite making a correct decision. The purpose of the present study was to examine the influence of a position-specific intervention on midfield-specific performance using subjective scoring.

Four self-reported soccer midfielders (Age mean = 23.5, $s = 2.1$) who participated in a British University Sports Association 1st team squad gave their consent to participate. Data for “Typical physical skill ability” (TPSA) and “Typical decision-making ability” (TDMA) were collected over a ten-match league period by a Football Association Level 3 coach in a single-subject, multiple-baseline across individuals design. Both TPSA and TDMA represented subjective measures of the dependent variables employed in previous studies. The intervention comprised self-talk, relaxation and imagery, and was administered to each participant once they had achieved a stable baseline for the dependent variables. As such, one individual received the intervention after match 3, the second after match 4, the third after match 5, and the fourth after match 6.

The data were analysed following the recommendations forwarded by Hrycaiko and Martin (1996: *Journal of Applied Sport Psychology*, 8, 183–199). Resultant visual inspection of the TPSA data revealed all but one participant improved mean performance, albeit marginally, post-intervention. However, there were many overlapping data points across pre- and post-intervention phases for each participant, which questions the consistency of the intervention effect size. The TDMA data were slightly better where despite several overlapping data points, all participants experienced immediate, yet small improvements post-intervention.

The results suggest that three midfielders experienced at least small performance improvements in both variables post-intervention, although caution is advised when interpreting the findings due to the overlapping data points. That said, researchers and practitioners are both encouraged to explore ways of intervening at a “role” level within sports, and also consider the most appropriate methods for performance assessment. As such, future research should directly compare objective and subjective approaches.

HPHP4-38

Muscle force production following unaccustomed eccentric exercise

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Unaccustomed eccentric exercise results in exercise-induced muscle damage (EIMD), with symptoms including reduced muscle function, muscle soreness and the appearance of intramuscular components in blood (Howatson & van Someren, 2007: *European Journal of Applied Physiology*, 101, 207–214). These symptoms are commonly used as indirect markers of EIMD; however, the relationship of these markers with muscle function following

damaging exercise is unclear. The aim of this study was therefore to determine the relationship of indirect markers of EIMD with the force generating capacity of muscle.

Forty-eight male participants, who were unaccustomed to eccentric exercise, performed three sets of 15 maximal lengthening contractions of the elbow flexors at $30^{\circ} \cdot s^{-1}$. Elbow flexor isometric torque (MVC), creatine kinase in blood (CK), muscle soreness (SOR), elbow range of motion (ROM) and upper arm girth (GIR) were measured pre-exercise and at 48 h and 96 h post-exercise. MVC, ROM and GIR were expressed as percentage change from baseline (%MVC, %ROM, %GIR, respectively) and CK data were log transformed (logCK) for statistical analysis.

At 48 h post-exercise, %ROM and logCK were correlated with %MVC ($r=0.35$, $P=0.014$ and $r=-0.30$, $P=0.042$, respectively). At 96 h post-exercise, %ROM and logCK were again correlated with %MVC ($r=0.49$, $P<0.001$ and $r=-0.32$, $P=0.027$, respectively); in addition, %GIR and SOR were correlated with %MVC ($r=-0.43$, $P=0.002$ and $r=-0.41$, $P=0.004$, respectively). Cluster analysis of %MVC identified two groups at 48 h post-exercise: high responders ($N=18$, average decrement = 36.5%) and low responders ($N=30$, average decrement = 11.8%), and two groups at 96 h post-exercise: high responders ($N=8$, average decrement = 44.2%) and low responders ($N=40$, average decrement = 6.3%). Discriminant function analysis demonstrated that %ROM alone predicted group membership at 48 h post-exercise ($F=0.841$, $P=0.005$), accurately predicting 67% of high responder and 80% of low responder cases. At 96 h post-exercise, %GIR alone predicted group membership ($F=0.828$, $P=0.003$), accurately predicting 63% of high responder and 80% of low responder cases.

This study demonstrates that the reduction in voluntary muscle function following damaging exercise can be predicted by indirect markers of EIMD. These findings provide further insight into the effects of EIMD on muscle function and have implications for the management of athletic training.